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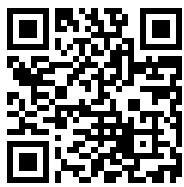

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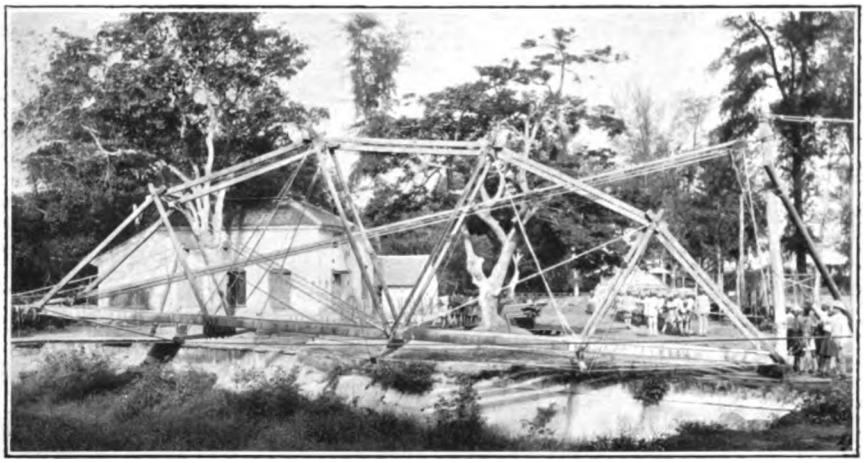

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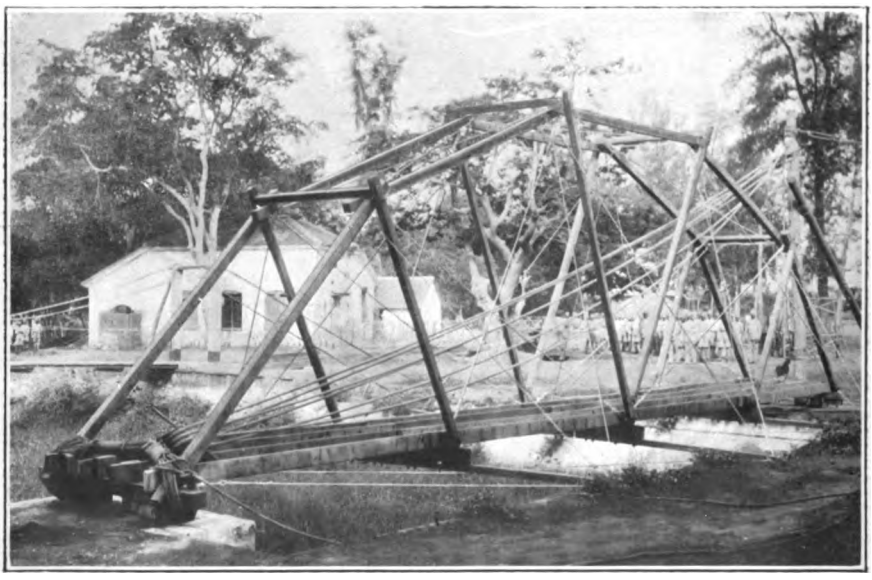

Far End of Bridge Lowered into Final Position.

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A PORTABLE FIELD GIRDER.

MARK II.

By Bt. Major R. L. McClintock, d.s.o., R.E.

In the July number of the *R.E. Journal* there appeared an article describing a Portable Field Girder, in the construction and launching of which certain experiments had been carried out at Bangalore by the "Queen Victoria's Own" Sappers and Miners.

Faults of Original Pattern.—The original girder bridge on closer acquaintance, however, appeared capable of improvement in two directions :—

(*a*). In longitudinal stiffness.

(*b*). In vertical rigidity.

Any lack of the former quality affects this type of bridge both during the operation of launching and when under a load, causing a tendency to buckle sideways in each case. On the original bridge this tendency was somewhat marked during launching, and had to be neutralized by temporary cross-bracing placed horizontally at the road level. When under a load the buckling tendency was very much less, and the usual wind-ties from each side of the bridge to the banks were sufficient to resist it.

The lack of *vertical* rigidity only affected the bridge during launching, at which time the tie-beams of the girders came into compression and had a tendency to buckle upwards out of the horizontal plane, which, if permitted, would have led to the "shutting up" of the girders. This tendency was met by lashing temporary struts up and down across the girders, as explained in the para. "Launching Expedients," and shown in *Photos* 1, 2 and 3 of the original article. Both the horizontal cross-bracing and these struts were removed as soon as the bridge was safely across the gap.

Now, if the bridge were to be truly portable, it was necessary to cart about these temporary additions equally with the other components of the girders. So it seemed that they might as well be incorporated with the system at once—especially if any additional and permanent rigidity was to be gained thereby. In this it seemed as if they might be substituted for certain other parts of the bridge, such as the main ties OB, MC, MD, and NE (*vide Fig.* 3, original

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article). These, being made of timber instead of wire, would thus be capable of first acting as struts during launching (and so prevent the rising of the roadway), and later as ties, when the bridge came under a load.

In addition to the above alterations, the experiment was made to see whether a saving of weight could be effected by replacing the double 5 in. × 4 in. compression members AB, CD, EF (*vide* p. 4, line 13, and *Fig.* 3, original article) by single ones 5 in. × 5 in. in section, similar to the rest of the compression members BC and DF.

Mark II. Bridge.—On these lines a new 60-ft. girder bridge was constructed, which is fully described in the accompanying photos, plans and tables. It is calculated for infantry in file and loaded pack mules, or $3\frac{3}{4}$ cwt. per foot run dead load. The roadway is 6 ft. wide, and it is hardly necessary to point out that the construction of a narrow bridge like this is a more severe test of the system than would be one of similar span and a roadway of normal width.

This improved bridge is known as the "Bangalore Girder, Mark II.," and has given entire satisfaction both by its behaviour during launching and under its full load. There are now no extras of any sort to be added to the bridge for launching: it is put across the gap absolutely complete except for the chesses. The system is also quite rigid in every direction under all conditions, and so stiff horizontally that wind-ties are hardly necessary. The gain in individual stiffness of the two girders, due to the above substitution of timber ties for certain of the wire ties, also considerably facilitates the putting together of the bridge prior to launching.

In addition to the alterations already mentioned, the experiment was made of providing each shore transom with two runners (*Fig.* 11, *Plate* II.) both to facilitate the rotation of the near shore transom round the foot of the derrick during launching, and to enable the bridge to be moved slightly forwards or backwards after launching, should this be necessary. They are advantageous but not essential.

Weight of Complete Bridge.—The increase of launching weight of Mark II. over the original bridge is the difference between 5,799 lbs. and 5,436 lbs.—*i.e.* 363 lbs. The weight of the original bridge as given (5,436 lbs.), however, was exclusive of the temporary struts and cross-bracing, which were necessary in launching it. These are now included in the total weight of Mark II. (5,799 lbs.), and as they represent well over 600 lbs., a distinct saving has been attained by the new design. The whole bridge (Mark II.) including chesses can now be carried in eight two-wheeled Indian ox-carts.

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Launching.—The method of launching Mark II. is identical with that described in the original article, no improvement on that system having been discovered. As an experiment in shortening the derrick as much as possible, the 60-ft. bridge (Mark II.) was launched complete—except for chesses—with a *twenty*-ft. derrick and a $4\frac{1}{2}$-in. tackle, the operation of raising, swinging and lowering occupying just five minutes. Convenient trees were used instead of artificial holdfasts for the derrick guys.

Durability.—As regards the durability of this type of bridge it is impossible to speak without longer experience. The bridge shown in the photos, however, has been launched, picked up and relaunched several times during the last six months; has been loaded from time to time with various sorts of loads; and has in the intervals stood across the gap shown, enduring an Indian hot-weather and rains without so far showing any signs of decay.

NOTE.—My thanks are due as before to Regtl. Sergt.-Major King, R.E., and Q.M.S. Instr. Dolan, R.E., of the "Q.V.O." S. & M., who respectively assisted me in the design of the bridge and its launching, and also to Sergt. Short, R.E., who prepared the working drawings.

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Weights and Sizes of Component Parts of 60-ft. Bangalore Girder Bridge, Mark II.

Name or Position of Piece.	Size of Section. Ins.	Ins.	No. of Pieces.	Weight of each. Lbs.	Total Weight. Lbs.	Remarks.
Woodwork.						
Compression members	5	5	10	164	1640	Timber: "Honnee" or "Honay" (Pterocarpus marsupium). Weight: 56 lbs. per cubic foot.
Tie-beams and road-bearers	8	2	16	84	1344	
Main ties (timber) long	4	4	4	120	480	
„ „ short	4	4	4	100	400	
Shore transoms ...	9	6	2	150	300	
Roadway transoms ...	8	4	3	102	306	
Cross struts	4	4	4	40	160	
Outriggers	4	4	6	65	390	
Blocks	–	–	8	8	64	
Ironwork.						
Eye-bolts (S)	$1\frac{1}{4}$" round		8	10	80	
Eye-bolts and brackets (TU)	1"	„	20	16	320	
Main ties, $1\frac{1}{2}$ in., long	$1\frac{1}{2}$" circum.		4	15	60	
„ short	„	„	4	10	40	
Runners, complete with brackets (shore transom)	—	—	4	25	100	
Top bracing, 1-in. cable	1" circum.		1	25	25	
Horizontal bracing, with straining screws ..	1"	„	1	30	30	
Outrigger bracing, with straining screws ...	1"	„	2	30	60	
					5,799	

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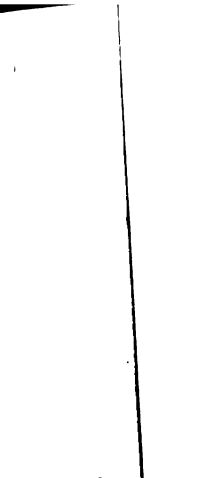


FIG. 1.

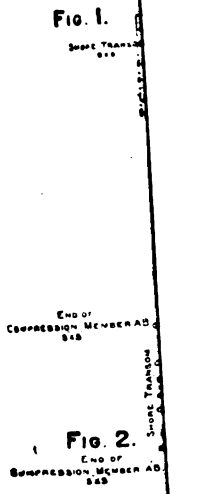


FIG. 2.

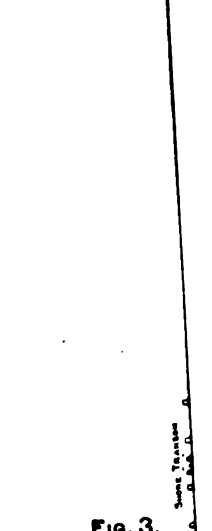
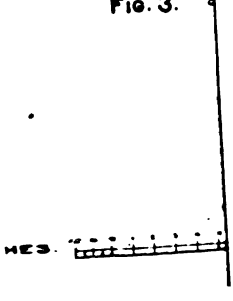


FIG. 3.



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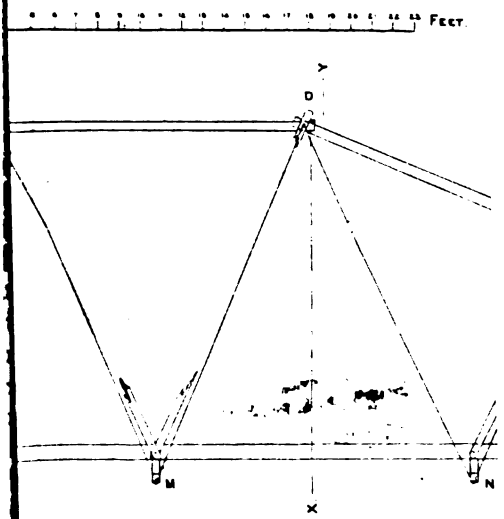
RE" GIRDER BRID

MARK II.



SHEWING OUTRIGGER BRACINGS.—

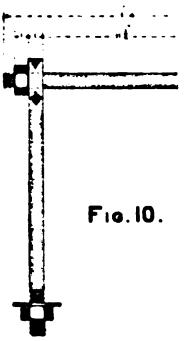
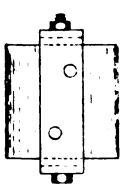


Fig. 10.

Bracket Complete Securing Tie Beams, & Compression Member to Transoms

Fig 11.



Plan of Runner Bracket

Scale for D

Inches 12

Transom

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FURTHER NOTES ON THE EMPLOYMENT OF ROOF TRUSSES FOR BRIDGE REPAIRS.

By Capt. W. G. S. Dobbie, R.E.

In Capt. Borton's interesting article on bridge repairs, which appeared in the December, 1912, number of the *R.E. Journal*, he pointed out that if the tie beams of the trusses were to be loaded, it would be necessary to use six trusses instead of four to carry infantry in fours. This of course involves the expenditure of extra time and trouble in taking down the two extra trusses and in transporting them to the site of the bridge. Further, the three trusses on each side of the bridge are rather unwieldy, especially in cases where lateral space is a consideration. The difficulties arising from the loading of the tie beam may, I think, be more easily avoided, by hanging the roadway in slings supported at the various joints in the principal rafter. In the case of a king post truss there would be three slings, viz. one at the ridge, and one at the end of each of the struts. The following stress diagrams show that loading the truss at the ridge in this way will not unduly strain it.

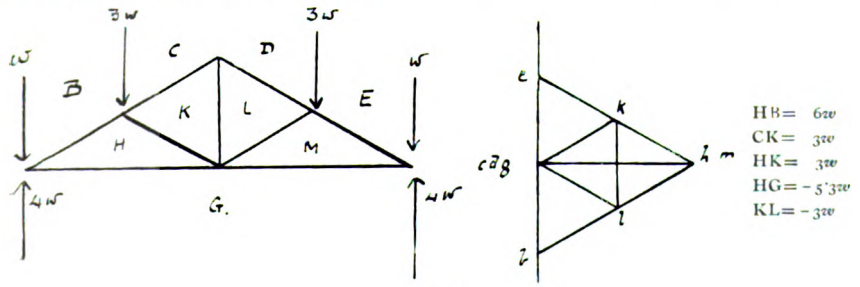

Fig. 1.

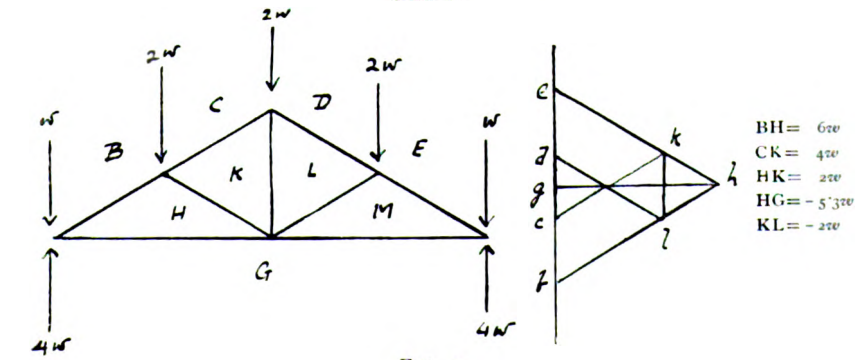

Fig. 2.

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In *Fig.* 1 the truss is shown loaded in the normal way for a roof, *i.e.* in the way for which it was originally calculated.

In *Fig.* 2 the truss is loaded as now suggested, and it will be noticed that no member is subjected to a greater stress than before, with the exception of *ck*. This, however, will not matter as the principal rafter will naturally be the same size all the way along. If then three road transoms (in the case of a king post truss) are slung in the manner suggested, the truss will be able to stand it.

Similarly queen post trusses can be shown to be capable of standing a load applied at the ridge. Iron roofs are usually calculated for loads applied in this way.

As regards the slings, the weight which has to be carried by them is not very great. In the case of a king post truss each pair of slings has only to take one quarter of the total load. With a queen post truss, each pair has to take one-sixth of the load, and so on. In fact, in most cases it will be found that the road transoms will not have to be spaced more than 7 ft. apart, and each sling will therefore have to carry no more than $\frac{1}{2} \times 7 \times 1\frac{5}{2}$ cwt., or $26\frac{1}{4}$ cwt. It should not be difficult to find suitable material for slings in these circumstances.

For the transoms, the purlins will usually be suitable. In the case of a 30-ft. span, and a king post truss the load on each transom will be $\frac{30}{4} \times 5$ cwt. $= 37\frac{1}{2}$ cwt.

Supposing the slings are 10 ft. apart laterally, and using the rough formula $w = \frac{bd^2}{L}k$, we get $bd^2 = 375$ or $b = 4\frac{3}{4}$ in. and $d = 9$ in. According to the table in Hurst the purlins for 30-ft. trusses, if spaced at 10 ft. will be $5\frac{1}{2}$ in. $\times$ 9 in., which would consequently be strong enough, unless the trusses were spaced less than 10 ft. apart. The common rafters would no doubt serve as road bearers.

This method of hanging the roadway has the additional advantage that the level of the roadway can be more freely adjusted, by arranging the length of the slings to suit the particular gap. Instead of only having two levels at which the roadway could be laid, far more freedom is now allowed, and this might on some occasions prove a very great convenience.

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THE ORDINARY VERSUS THE QUENCHED SPARK IN WIRELESS TELEGRAPHY.

By LIEUT. A. C. FULLER, R.E.

IN the early days of wireless, the single oscillating circuit transmitter was invariably used. In this method, the only high frequency oscillation circuit was the aerial circuit consisting of the elevated aerial wire—the spark gap—and thence to earth. The capacity necessary for oscillations to occur was that of the aerial itself with respect to the earth—the inductance again that of the aerial, with perhaps an additional portion in the shape of a few turns of wire to increase the wave length.

A transmitter of this kind is not very efficient for the following reasons :—(*a*). It can have but little capacity and hence can store but a small quantity of energy. (*b*). It has a large damping factor, and hence oscillations do not persist but rapidly die out.

As the science improved and long distance work began to be attempted, the closed circuit transmitter became practically universal. The general use of syntony in wireless also caused persistence of oscillation to be desirable. The closed circuit of an ordinary modern spark system transmitter can store a large amount of energy owing to the large condensers provided; it also possesses persistence of oscillation.

There is almost no limit to the amount of energy that can be stored in a closed circuit of the ordinary type if the correct precautions are taken and the necessary conditions are fulfilled. Such a circuit will also oscillate freely and persistently and with a true time constant; it cannot however radiate.

In order to obtain radiation this closed circuit has to be combined with an open or aerial circuit. The two circuits are brought into inductive relationship, so to speak, and the almost ideal conditions obtaining in the closed circuit when examined by itself are found no longer to exist.

The obvious intention of combining these two circuits, is that the oscillations of the closed circuit shall be set up in the open circuit by induction; that this latter circuit shall radiate the energy thus obtained; that the closed circuit shall continue persistently to oscillate, with the result that the open or radiating circuit can receive fresh supplies of energy from the closed circuit; hence the energy stored up in the condensers of the closed circuit is, or should be, usefully radiated from the open circuit.

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If this programme was carried out in precisely the manner indicated, a very efficient transmitter would result, for the two desirable conditions would both be fulfilled, namely a great quantity of energy would be stored up, and this great quantity would be usefully radiated in the form of persistent waves.

This, however, does not occur in its simplicity, for, since action and reaction are equal, the secondary circuit, when its oscillations have reached a certain amplitude, begins to react on the primary circuit which thus becomes a drag or useless load on the secondary circuit. This of course is due to the mutual inductive effect of the two circuits, and there is a continual give and take of energy between them, instead of the ideal condition of the primary doing all the giving, and the secondary doing all the taking. The oscillations induced in the secondary circuit grow in amplitude until the primary oscillations become a minimum, when the energy is transferred in the opposite way and the amplitude of the primary oscillations in turn begins to grow as the secondary oscillations diminish.

The following curves make the state of things clear :—

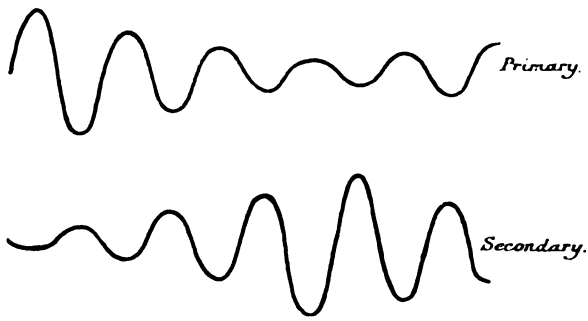

FIG. 1.

It will be seen that the energy is radiated in the form of beats and the total energy radiated, is not as great as that sent out with like power conditions by a slightly damped persistently oscillating aerial circuit.

There is yet a further disadvantage of this method of transmission. We have just seen that energy is wasted, owing to the primary re-absorbing energy from the secondary, which forms as it were a drag on it ; but in addition to this there are present in each circuit two waves of different frequencies. Of these waves, one is rather longer and the other rather shorter than the true natural wave length of the circuit by itself. The actual presence of these two waves can be detected by a wave meter, for they can each be measured.

The reasons for their existence are not difficult to follow. When the primary is imparting energy to the secondary, the primary is so to speak being retarded and the secondary is being accelerated ;

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when the transfer of energy is reversed the circuits are affected contrariwise.

It comes to this, then, that helping and opposing electromotive forces are alternately brought to bear in each circuit, causing this double wave to be produced. The drawback of this double wave is that the energy of only one of them is of use to operate the distant receiving instruments, the receiving station being out of tune for the other wave whose energy for practical purposes is wasted.

To sum up, then, the ordinary spark system, or what is known as the Marconi System, appears to have two chief disadvantages. These disadvantages are both due to the mutual action between the primary and secondary oscillating circuits, or, in a word, to the persistence of oscillations in the primary circuit. These disadvantages are minimized by having a low percentage of coupling, but this entails a waste of energy.

The essential feature of the Quenched Spark System is that as soon as the primary circuit has imparted its energy once to the secondary circuit, the primary becomes electrically incapable of oscillating at all, until the next spark occurs, say, $\frac{1}{500}$ of a second later at a spark frequency of 500.

This condition immediately removes the two disadvantages pointed out above, for the secondary is now free to oscillate quite independently of the primary, which having done its useful work takes no further part in the proceedings.

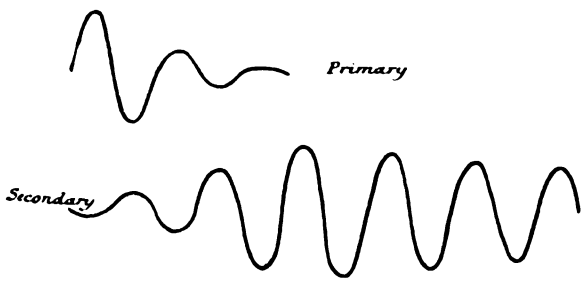

FIG. 2.

Fig. 2 represents the oscillations in the two circuits of the Quenched Spark System. It will be seen that the secondary oscillations become a maximum just when the primary has imparted all its energy, and that from that point a persistent train of slightly damped oscillations continues in the aerial circuit.

The total useful energy thus radiated is far in excess of that obtained from the ordinary spark system under similar conditions of power, etc. This can readily be seen when it is realized that the secondary circuit is free to oscillate without the restraining influence of the primary, and that all the energy is transmitted by one wave, for there is no trace of a double wave in the aerial circuit. The

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writer hopes in a further article to consider the conditions necessary to obtain a "Quenched Spark," and to go generally into the details of the system.

Attached are figures showing results of a comparative test of the two systems. It is to be understood that the conditions as to power used—capacity of primary circuits, aerial, etc.—were identical. The inductances had to be altered slightly for tuning purposes, owing to the difference in resistance of the "Quenched" spark and "ordinary" spark.

	Ordinary or Marconi.	Quenched Spark.
Root mean square value of current in secondary	3·7	6
Overall efficiency ratio	13·7	36
Logarithmic decrement for damping ...	·167	·063
Ratio of persistence (relative number of oscillations for each spark)	29	74
Coupling*	10%	18%

With the aid of a four-faced mirror revolving at some 7,000 R.P.M. some instructive photographs of the sparks were taken. Photographs were taken of the ordinary sparks which clearly showed the effects of beats—as far as can be seen each wave train seemed to comprise from 20 to 24 sparks. It is an open question whether the oscillations continued for a longer period, but not with sufficient light intensity in the spark to show on the photograph.

There appeared to be no very obvious difference in the duration of the spark in the primary, and of a small spark across the gap inserted in the secondary. This secondary spark however seemed to endure rather longer. In the "Quenched" spark photos, the primary spark appears very intense. Three distinct sparks and sometimes four are visible, but no more. The spark in the secondary endures considerably longer, and this is very clearly seen when looking at the two sparks simultaneously in the mirror.

These photographs bear out in a striking manner the advantages claimed for the "Quenched" spark.

Up to the time of writing, a photograph has not been obtained showing the sparks in the primary and secondary (Quenched System) on the same plate simultaneously, but such a photograph would afford a very useful practical indication of the relative and actual persistence of oscillations in the two circuits.

I wish finally to mention that I was enabled to see these photographs, and the sparks themselves, in the rotating mirror through the kindness of Mr. Chambers of the Helsby Wireless Company, to whom my thanks are due.

* Coupling reduced to minimize double wave effect.

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CONCRETE GROYNE AT CLACTON-ON-SEA.

By 2ND LIEUT. H. S. BRIGGS, R.E.

THE following is a brief report on the construction of a concrete groyne now being made at Clacton, and shows one of the measures being taken for the prevention of coast erosion on the East Coast. No important deviation from common practice is involved, and the general dimensions are such as have already proved satisfactory in the construction there of a similar groyne.

Object of the Groyne.—It has been found that the N.E. winds have the effect of carrying the sand and shingle in a south-westerly direction, *i.e.* down the beach: the westerly and south-westerly winds are not powerful enough to carry the stuff back. The result is that the beach is gradually being washed down the coast, and out of the Town Council's land. During the last two years the beach level at the S.W. boundary of the Council's foreshore has fallen something like 18 inches. To prevent this scour it was decided to erect a groyne which would check the movement of the shingle, etc. To let through any shingle which might be carried during a west or south-westerly wind, a sluice was to be provided in the groyne which could be opened during these winds and closed when the wind was in the opposite direction.

Construction.—The groyne is practically a solid block of concrete carried down to the natural bed of Platimore (London clay), which provides an excellent foundation. The upper surface is stepped to follow the slope of the beach. A batter is given to the sides. Other details can be seen from the *Plate*.

Concrete.—The face of the groyne is of granite chippings and Portland cement in the proportion of 3 to 1. It is afterwards grouted with cement and rubbed down with a brush. The remainder is of pit ballast and Portland cement in proportion of 3 to 1. The work has to be done between tides. With two men laying the stuff, a layer of 2 ft. × 50 ft. can be usually completed at a time. A layer of burrs is placed between each layer of concrete. The end of each layer is keyed into the one contiguous to it (see *Plate*). The concrete is mixed with sea water at the shore end of the groyne; the mixture here is practically dry—about 15 per cent. of water only—and it is carried to the head of the groyne and there mixed with the requisite amount of water *in situ*. The drop from the barrow to the work is from 12 ft. to 13 ft. Six men are employed in mixing and carrying the stuff.

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Timber Work.—No underwater work is required, but an exceptionally low tide will be required for the last 50 ft. or so of the groyne.

King-Piles are 12 in. × 12 in., shod with W.I. 3-faced nose. The pile driver used is hand-worked with a fall 4 ft. to 9 ft. and 3-cwt. monkey. A pile usually takes 1½ to 2 hours to drive. No difficulty up to the present has been found with this part of the work. Each transverse pair of piles is tied by a 1-in. tension rod. When the work is completed the former are cut off level with the lower edge of the battered face of the groyne. King-piles are spaced with 10-ft. centres.

Sheet Piling is of 12 in. × 4 in. with a bevelled nose, and is driven in tight between the king-piles. For the construction of the battered portion of the groyne, a temporary wall of 2-in. sheeting is used.

Walings 6 in. × 12 in. and 3 in. × 11 in. secure the sheet piling on the outside and inside respectively; waling is secured to the king-piles by ¾-in. W.I. bolts. The king-piles, sheet piling, and waling will be left in position when the concrete is completed, the tops of the king-piles being sawn off. For convenience in bringing up the material, a temporary gangway of 9 in. × 3 in. is spiked to the heads of the piles (see *Plate*).

Sluice.—This is merely a 20-ft. gap in the concrete about 40 ft. from the shore end. The removable portion consists of 10 in. × 4 in. planks sliding in 6 in. × 6 in. × ¾ in. angles (see *Plate*). The planks will be shifted by hand when desired.

Cost.—The total cost is about £1,750, apportioned roughly as under :—

	£	s.	d.
Wages	600	0	0
Cement	230	0	0
Gravel, etc.	110	0	0
Bolts, angle irons, and tool repairs...	110	0	0
Water	5	0	0
Granite chippings	30	0	0
Pitch pine timber	650	0	0
Sundries	15	0	0
Total ...	£1,750	0	0

My thanks for the above information are due to Mr. D. J. Bowe, C.E.

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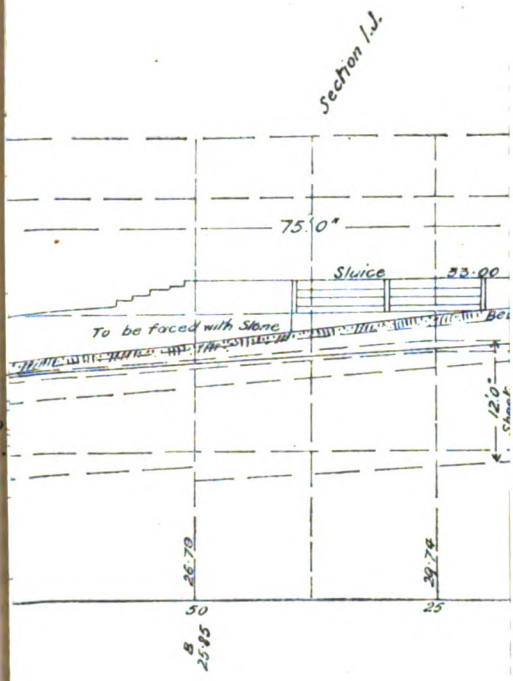
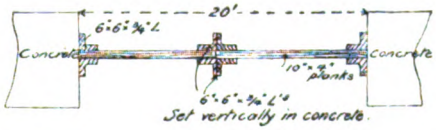
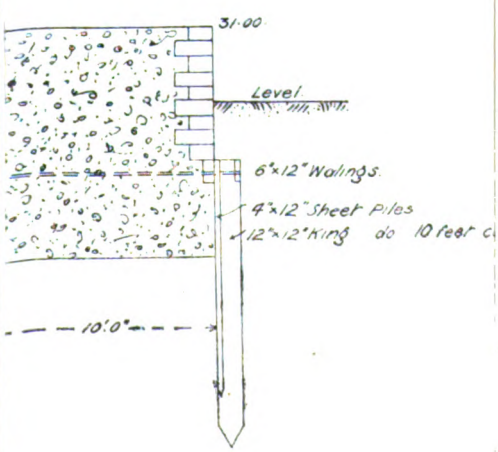




PLAN OF SLUICE.



SECTION I.J.

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PAPERS OF FIELD MARSHAL SIR JOHN BURGOYNE, BART., G.C.B.

AN interesting and valuable addition has recently been made to the R.E. Museum, by the inclusion of a large number of letters and documents written to, and by, Sir John Burgoyne. The papers not only include his Peninsula diaries, notes on the principal sieges, etc., etc., but also his letters and memoranda written in the Crimea, and various criticisms on the Histories of the War. Amongst other papers is the following letter from the Duke of Wellington which is of considerable historical interest. Written in January, 1847, as a criticism to a memorandum drawn up by Sir J. Burgoyne on the defenceless state of the country, it was sent to the press without his knowledge or permission by a lady to whom he had shown it. The hostile reception and bitter comments which it met with in the public press, deeply wounded the Duke who had considered it a confidential communication, and it is said that he never entirely forgave Sir John Burgoyne for its publication, although he was really in no way responsible for it.

In his article Sir John pointed out that "there may be in Great Britain and Ireland perhaps 30,000 regular troops including infantry and cavalry; of which at least from 20,000 to 25,000 must remain for the protection of Ireland, of garrisons, etc., leaving not more than 5,000 to 10,000 men disposable to oppose the efforts of ten times their number," and it is on these data that the Duke's remarks are based.

Although there was no apparent reason for such complications as referred to by the Duke, at the time the letter was written the Government of France was probably in an unsettled state. Early in the following year Louis Phillipe was driven from the throne and the Second Republic was proclaimed, and four years later this in its turn gave place to the Second Empire. The Crimean War, however, seemed to show the want of reserves, for Sir J. Burgoyne writing from before Sebastopol in February, 1855, says "When we started here we were in about equal force, each perhaps 25,000 men, and we took about an equal extent of ground to cover. Since then we are reduced to about 12,000, whilst they" (the French) "are augmented to above 70,000."

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Copy of a letter from Lord Wellington to Major-General Sir John Burgoyne, K.C.B., etc., etc.[*]

STRATFIELD SAYE,
9th January, 1847.

MY DEAR GENERAL,—

Some days have elapsed, indeed a fortnight has, since I received your note with a copy of your observations on the possible results of a war with France under our present system of military preparation.

You are aware that I have for years been sensible of the alteration produced in maritime warfare and operations; by the application of steam to the propelling of ships at sea! This discovery immediately exposed all parts of the coasts of these islands, which a vessel could approach at all, to be approached at all times of tide; and in all seasons, by vessels so propelled from all quarters. We are in fact assailable, and at least liable to insult, and to have contributions levied upon us; on all parts of our Coast; that is the Coasts of these including the Channel Islands; which till this time from the period of the Norman Conquest have never been successfully invaded.

I have in vain endeavoured to awaken the attention of different Administrations to this state of things; as well known to our Neighbours; Rivals in power at least, former adversaries, and enemies, as it is to Ourselves.

I hope that your paper may be attended by more success, than my representations have been!

I have above in few words represented our danger. We have no defence, or hope of chance of defence; excepting in our Fleet!

We hear a great deal of the spirit of the People of England, for which no Man entertains higher respect than I do, but unorganized, undisciplined, without systematic subordination established and well understood, this spirit opposed to the fire of Musquetry and Cannon, and Sabres and Bayonets of disciplined Troops, would only expose those animated by such spirit to confusion and destruction.

Let any man only make the attempt to turn to some use this spirit, in a case of partial local disturbance. The want of previous systematic Organization, and subordination, will prevent him even from communicating with more than his own menial Servants and dependants! and while Mobs are in movement through the Country, the most powerful will find that he can scarcely move from his own door!

It is perfectly true that as we stand at present, with our Naval Arsenals and Dockyards not half garrisoned; 5,000 Men of all Arms, could not be put under arms if required for any Service whatever, without leaving standing without relief, all employed on any duty; not excepting even the Guards over the Palaces and the person of the Sovereign!

I calculate that a Declaration of War should properly find our Home Garrisons of the strength as follows; particularly considering that one of the most common accusations against this Country is, that the practice

[*] No alteration has been made in the orthography of the letter.

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has been to commence reprisals at Sea; simultaneously with a declaration of War, the Order for the first of which must have been issued before the last can have been published.

We ought to be with Garrisons as follows at the Moment War is declared:—

Channel Islands besides the Militia of each, well organized, trained and disciplined	10,000 Men.
Plymouth	10,000 ,,
Milford Haven	5,000 ,,
Cork	10,000 ,,
Portsmouth	10.000 ,,
Dover	10,000 ,,
Sheerness, Chatham and the Thames	10,000 ,,

I suppose that one half of the whole Regular Force of the Country would be stationed in Ireland, which half would give the Garrison for Cork! The remainder must be supplied from the half of the whole force at Home stationed in Great Britain.

The whole force employed at Home in Great Britain and Ireland would not afford a sufficient number of Men, for the mere occupation and defence on the breaking out of War of the Works constructed for the defence of the Dockyards and Naval Arsenals; without leaving a single Man disposable! The Measure upon which I have earnestly entreated different Administrations to decide; which is Constitutional, and has been invariably adopted in time of Peace for the last 80 years; is to raise, embody, Organize, and discipline the Militia of the same numbers for each of the three Kingdoms united as during the late War. This would give a Mass of Organized force amounting to about 150,000 Men, which we might immediately set to work to discipline. This alone would enable us to re-establish the Strength of our Army! This with an augmentation of the Force of the Regular Army, which would not cost £400,000, would put the Country on its Legs in respect to personal force, and I would engage for it's defence! Old as I am!

But as we stand now, and if it be true that the exertions of the Fleet alone are not sufficient to provide for our defence, we are not safe for a Week after the declaration of War!

I am accustomed to the consideration of these questions; and have examined and reconnoitered over and over again the whole Coast from the North Foreland, by Dover, Folkestone, Beachy Head, Brighton, Arundel to Selsey Bill near Portsmouth, and I say that excepting immediately under the fire of Dover Castle there is not a spot on the Coast on which Infantry might not be thrown on shore at any time of tide with any wind and in any weather! and from which such Body of Infantry thrown on shore would not find within the distance of Five Miles a Road into the interior of the Country through the Cliffs, practicable for the march of a Body of Troops.

That in that space of Coast, that is between the North Foreland and Selsey Bill, there are not less than seven small Harbours or Mouths of

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Rivers each without defence, of which an enemy having landed his Infantry on the Coast might take possession, and therein land his Cavalry and Artillery of all calibre, and establish himself and his communication with France!

The nearest part of the Coast to the Metropolis is undoubtedly the Coast of Sussex from the East and West sides of Beachy Head and to Selsey Bill.

There are not less than twelve great Roads leading from Brighton upon London, and the French Army must be much altered indeed since the time at which I was better acquainted with it; if there are not now belonging to it forty Chefs d'Etat Major-General, capable of sitting down and ordering the March to the Coast of 40,000 Men; their embarkation with their Horse and Artillery at the several French Ports on the West, their disembarkation at named points on the English Coast; that of the Cavalry and Artillery in named Ports or Mouths of Rivers; and the assembly at named points of the several columns; and the March of each of these from Stage to Stage to London.

Let any Man examine our Maps and Road Books; consider of the matter, and judge for himself!

I know of no mode of resistance much less of protection from this danger, excepting by an Army in the field capable of meeting and contending with its formidable enemy! aided by all the means of fortification which experience in War and science can suggest.

I shall be deemed foolhardy in engaging for the defence of the Empire with an Army composed of such a force of Militia! I may be so! I confess it! I should infinitely prefer, and should feel more confidence in an Army of Regular Troops! But I *know* that I shall not have these! I may have the others, and if an addition is made to the existing Regular Army allotted for Home defence, of a force which will cost £400,000 a year, there would be a sufficient disciplined force in the field to enable him who should command to defend the Country!

This is my view of our danger and our resource.

I was aware that our Magazines and Arsenals were very inadequately supplied, with Ordnance and Carriages, Arms, Stores of all denominations and Ammunition. The deficiency has been occasioned in part by the sale of Arms and of every description of Ordnance Stores from time to time since the termination of the late War; in order to diminish the demand of Supply to carry on the Peace Services of the Ordnance; in part by the conflagration of the Arsenal which occurred in the Tower some years ago, and by the difficulty under which all Governments in this Country labour in prevailing upon Parliament in time of Peace to take into consideration measures necessary for the safety of the Country in time of War!

The state of the Ordnance, Arms, Ammunition, etc., in Magazine is in part a question of expense and perhaps in some degree one of Time. I would recommend to have the Alphabetical List of the Stores examined by a Committee; and made out in a form as upon the inclosed half sheet of Paper, by ascertaining what there was in 1804 and what there is in Store now of each Article and the difference between the two accounts.

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I have taken the year 1804 as the Standard as that was the year in which the Invasion was threatened; it was previous to the employment of the Armies in the Peninsula or North America. In short as nearly as possible similar to the political circumstances in which we stand at this moment; excepting that we are now at Peace with France. We were then at War!

A fourth Column would be the estimate of the expense of bringing the Magazines to the state in which they were in 1804!

With this information before him, The Master-General could give the Government accurate information of the wants of Ordnance, Arms, Ammunition and Stores in the Magazines of the Country.

You will see from what I have above written, that I have contemplated the danger to which you have referred. I have done so for years! I have drawn to it the attention of different Administrations at different times. You will observe likewise that I have considered of the measures of prospective security, and of the mode, and cost of their attainment! How such knowledge can be acquired. I have done more, I have looked at and considered these localities in great detail; and have made up my mind upon the details of their defence! These are questions to which my mind has not been unaccustomed, I have considered and provided for the defence, the successful defence of the Frontiers of many Countries!

You are the Confidential Head of the principal defensive Department of the Country! I will if you and The Master-General of the Ordnance choose, converse or otherwise communicate confidentially with you upon all the details of this Subject, will inform you of all that I know, have seen and think upon it, and what my notions are of the details of the defensive system to be adopted, and eventually carried into execution!

I quite concur in all your views of the danger of our position, of the magnitude of the stake at issue!

I am especially sensible of the certainty of failure, if we do not at an early moment attend to the measures necessary to be taken for our defence and of the disgrace, the indelible disgrace of such failure. Putting out of view all the other unfortunate consequences, such as the loss of the political and Social position of this Country among the Nations of Europe; of all it's Allies, in concert with, and in aid of whom, it has, in our own times, contended successfully in arms for it's own Honour and safety, and the independence and freedom of the World!

Where did any Man hear of Allies of a Country unable to defend itself? Views of economy of some and I admit that the high views of National Finance of others induce them to postpone those measures absolutely necessary for mere defence and safety under existing circumstances, forgetting altogether the common practice of successful Armies, of all Armies in modern times, imposing upon the conquered enormous pecuniary contributions, as well as of other valuable and Ornamental Property.

Look at the course pursued by France in Italy and Germany and Russia. At Vienna repeatedly, at Berlin, at Moscow, the contributions levied beside the subsistence, maintenance, clothing and Equipments of the Army which made the conquest! Look at the conduct of the Allied

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Army which invaded France and had possession of Paris in 1815. Look at the account of the pecuniary sacrifices made upon that occasion under their different Heads of Contributions; payments for subsistence and maintenance of the invading Armies including Clothing and other Equipments. Payment of old repudiated State Debts! Payment of Debts due to Individuals in War in the different Countries of Europe. Repayment for Contributions levied, and movable and immovable property sold in the course of the Revolutionary War.

But such an account cannot be made out against this Country. No! But I believe that the means of making some demands would not be wanting! Are there no claims for a Fleet at Toulon in 1793? None for debts left unpaid by British Subjects in France who escaped from confinement under cover of the Invasion in 1814 by the Allied Armies? Can any man pretend to limit the amount of the demand on account of Contribution de Guerre?

Then look at the conditions of the Treaties of Peace of 1814, 1815.

France having been in possession of nearly every Capital in Europe, and having levied contributions in each, and had in its possession or under it's influence, the whole of Italy and Germany and Poland, is reduced to it's Territorial limits as they stood in the year 1792.

Do we suppose that we should be allowed to keep, could we advance a pretension to keep, more than the Islands composing the United Kingdom? ceding disgracefully the Channel Islands on which an Invader had never established himself since the period of the Norman Conquest!

I am bordering upon Seventy Seven Years of Age! past in Honour!

I hope the Almighty may protect me from being the Witness of the Tragedy, which I cannot persuade my contemporaries to take measures to avert.

Believe me,
Ever Yours most sincerely,
(Sd.) WELLINGTON

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THERMIT WELDING FOR TRAM RAILS.

By Capt. D. Hoysted, R.E.

While driving through the streets of Alexandria a short time ago, I noticed that the system of electric trams was being extended and that, when putting down the new rails, the workmen were welding all the joints, instead of fishplating them to allow for expansion and contraction.

The lowest average temperature in the shade in this part of Egypt is 32° F. while the highest is 104° F. The first is a night reading, and the second is a reading by day, to which 50° F. may be added to obtain the highest average heat of the sun to which tram rails are subjected. This gives a difference of temperature of 122°. But the tram rails, when laid flush with the street, are mostly protected from the heat of the sun by their covering of concrete and road material. In addition, this covering being in the form of a homogeneous mass is capable of producing a sufficient stress to counteract the expansion of the heated rail. Thus, if a steel bar is warmed and compressed with an equivalent force, it will retain its original length, and it has been found in practice that this method is quite safe, even in a hot climate like Egypt, for steel rails buried up to the tread, and that the welded lengths do, as a fact, remain apparently unmoved in their beds.

The method of making the joint is a very interesting and simple affair though the heat to be developed is very high. The chief requirement is to obtain a level joint so that there will be no jump or displacement when the car wheels pass over it, and at the same time to secure complete and permanent electric continuity.

This the Thermit Process professes to do. Thermit is a mixture of aluminium and oxide of iron in certain proportions and in a granular state. Such a mixture has remarkable properties. It may be stirred with a red-hot iron, or molten cast iron may be poured on the top of it without result. If, however, any portion, and quite a small portion is sufficient, be raised to a temperature of 3,000° or 4,000° F. then the aluminium at once reduces the oxide of iron and forces it to part with its oxygen, in order that it may seize upon the oxygen itself and become oxide of aluminium. The heat thus produced is sufficient to leave the iron so formed and the oxide of aluminium (alumina or emery), both in a fluid state at a temperature of over 5,000° F.

But it has been found that if the contents of a crucible in which a

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quantity of thermit has been fired are poured on two butted rail ends in a mould, the alumina slag which is the lighter will run first and form a film on the rails, and the heavier molten iron which comes after never gets a chance of forming a real fluid contact with them. By this means the heat of the thermit may certainly be used, but the iron, as iron, would be wasted.

This makes it necessary to devise some expedient for ensuring that the reduced iron should be delivered to the rails first, so as to thus melt the surface and adhere to the steel rails and become a single piece with them.

If this can be done the slag which follows will merely fill up the mould, and retain the heat until the whole section of the joint can be brought to a uniform high temperature and a thorough weld secured.

The temperature thus obtained is greater than is actually required for the work in hand, and experience has shown that it is better to reduce it slightly. This is done by adding to the thermit mixture about 15 per cent. by weight of wrought iron in the shape of filings, etc.

Thermit contains nearly half its weight in iron which is available as metal, and with the addition of 15 per cent., the yield becomes nearly two-thirds of metallic iron.

Tram rails of 100 lbs. per yard run, require 22 lbs. of thermit for a satisfactory joint, and thus nearly 14 lbs. of iron is available to form a strengthening shoe, a shoe not bolted or clamped but absolutely homogeneous with the rest of the rails.

In actual practice, the butted ends of the rails, when they have been brought to this high temperature, are very slightly but forcibly drawn together by means of two screw clamps so as to make sure of as perfect a weld as possible. This upsets the metal at the tread to a small extent and the irregular surface thus formed must afterwards be planed true.

The mould in ordinary use is made of fireclay placed round the desired point of junction and banked up with sand, and above it is placed a conical crucible resting on an iron tripod.

A small rod projects through a small hole in the bottom of the crucible, and rests on the spade-like end of a short lever which stands on the top of the mould. This rod is a piece of ¼-in. iron bar and reaches nearly to the top of the hole piercing the bottom of the crucible. The top of the hole is closed with an iron disc, covered with a little asbestos and sand over which the charge of thermit mixture and filings is placed. The crucible consists of sheet iron lined with baked magnesia.

To ignite the charge, a thimbleful of a special mixture is placed on the top of the charge and lit with a fusee. This produces an intense local heat and starts the reaction in the charge, which becomes a molten mass in less than half a minute. As soon as the mixture is

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melted the spade-like lever is forced up, lifting the rod and the covering over the exit hole. At the same time the spade lever is removed. The molten iron runs first around the joint and is followed into the mould by the slag. After waiting three minutes till the butted ends of the rails are uniformly heated, the clamps are screwed up about half an inch and the joint is allowed to cool for a couple of hours. The fireclay mould is then broken up with a hammer, and the mass of alumina slag, which fills the upper part of the mould just clear of the rail, is knocked off and is available as a by-product for use in emery works. I saw a joint cut through the middle and was unable to find the slightest irregularity in the exposed section or any sign of want of homogeneity.

The igniting mixture is kept a secret by the manufacturers of thermit, and is supplied in bags with the charges.

I am indebted for the above information to the courtesy of the Director of the Alexandria Tramway Company.

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FERRO-CONCRETE DOOR FOR A RACQUET COURT.

By MAJOR A. R. WINSLOE, D.S.O., R.E.

FOR those interested in racquets, the following description of a ferro-concrete door made at Quetta may be useful in places where uncovered courts exist. In such cases the best wooden doors give trouble in time, whereas a well-made ferro-concrete door gives no trouble. The details of the door are shown in the *Plate*.

The cement concrete consists of 1 part Portland cement, 1 part sand, and 2 parts broken stone ballast (pea size to $\frac{1}{2}$ in.). The reinforcement consists of $\frac{1}{2}$-in. expanded metal on a frame of 1 in. × 1 in. × $\frac{1}{8}$ in. angle iron, stiffened by diagonals of round bar $\frac{1}{3}$ in. in diameter. Excluding the diagonals, the reinforcement works out to 2 per cent. nearly. In setting, care must be taken to allow the air to get at both surfaces, otherwise warping will take place. The first door constructed was made to shut against reveals in the racquet court wall. The weight of door however was so great that the continual shutting damaged the edges of the door.

A free swinging door (as shown in *Plate*) was then made to run on a racer, and there is no difficulty about opening or shutting this. The improvement in the game made by a door of this sort is very great, for the resiliency is considerable ; and, though the ball does not come off with quite the same force that it does off the adjacent racquet court wall, it comes off quite true.

In fact I think that if the door were made 2 in. thick instead of 1$\frac{1}{2}$ in., the difference in resiliency would be hardly noticeable. This is important in a fast game. A reduction in the size of the door could be easily made to keep down its weight.

The inner face of the box to contain balls should also be of ferro-concrete. Such a door would, I think, prove useful in covered courts.

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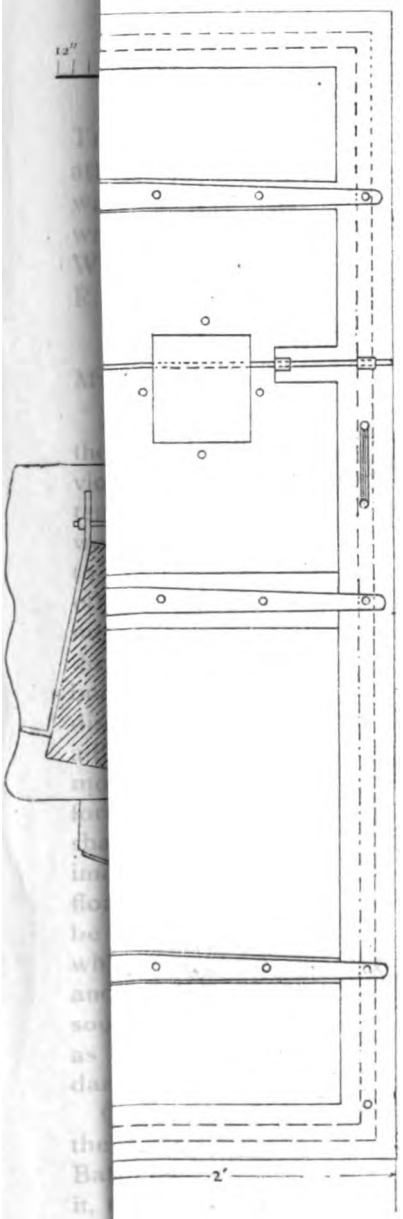
REI

ELEVATION.



L IRON

Racquet Court
Floor

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THE SIEGE OF GIBRALTAR.

THE following interesting letter giving a detailed account of the attack by, and destruction of, the Spanish floating batteries in 1782, was written by Sir William Green to his son-in-law, Mr. Nicols. It was given by his grandson, General Nicolls, R.A., to Major-General Whitworth Porter, R.E., and has been recently handed over to the R.E. Museum.

GIBRALTAR,
20th Sept., 1782.

MY DEAR NICOLS,

Ever since May and June last, the enemy have been perceived to make the most active, extensive, and formidable preparations possible, for a violent and vigorous attack of this place both by sea and land. Their ten great floating batteries, (or ships fortified and converted into such) were commenced upon at Algeziras, about the middle of May, and seemed to be got all perfectly ready about the 1st of September, as was every other preparation by sea, including 3 bomb ketches, 16 Gun Boats, 8 mortar boats, 16 large boats with mantlets across their bows, to let down with a hinge for the easier disembarking of troops, about 30 boats of a particular kind for the readier taking the shore, carrying and disembarking of troops, besides about 2 or 300 boats, brought from the adjacent coasts, to assist in throwing troops ashore, and other occasional movements peculiar to such attacks, besides a kind of floating battery or fort, of a particular construction, which I took to be intended for our shallow waters, in order to perfect those breaches, by which they imagined, (or had planned) were to be first opened by their large floating batteries. The whole of this sea attack, as we thought, was to be supported by 9 line of battle ships (7 Spanish and 2 French) and which had been in the bay for some time. And *with them only*, on the 9th and 10th instants, made a flying irregular attack under sail, upon our southern defences, which was answered by such of our batteries as could properly bear upon them, but without any material effect, or damage on either side.

On the 8th September, we set on fire by the means of redhot shot, their most centrical battery upon the Isthmus, called by them the Mahon Battery of 6 guns, besides a battery of two guns, just finished, adjoining it, notwithstanding all their possible endeavours to prevent it, in which they lost some men.

On the 9th September, The Duke de Crillon, opened all his new batteries at sunrise. The chief of 64 embrazures besides his four new mortar batteries all which were keeped playing, chiefly upon our works

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upon the northern fronts, the 9th, 10th, and 11th rather with great activity and violence. But on the 12th to our great astonishment in comes their grand combined fleet, and anchored at the head of the bay, consisting of 41 large ships, 7 of which are 3 deckers, and now, conjointly with the foregoing 9, makes 44 of the line, and about 6 Fiftys, in all 50. A formidable fleet you'll say, and commanded by eight Admirals.

About the 15th August, arrived in their camp, to serve as Volunteers, the Count D'Artois, one of the French King's brothers, and the Duke de Bourbon, son (I believe) to the Prince of Condé, and towards the 10th September, arrived a great deal of Spanish and French Nobility and Gentry, to see Gibraltar knocked to pieces, and swallowed up; and accordingly as we suppose, everything being ready on the 13th September (the day after the arrival of their grand fleet) about seven in the morning, their ten large floating batteries were perceived to be under sail, and it was soon conjectured, intended to bear down and attack the garrison, and by ten o'clock, anchored, as we judge in their proscribed stations, the Southernmost not a great way to the South of the King's Bastion, off Columbine's Parade, and the Northernmost a little to the Southward of the Old Mole Head. They immediately began a furious well served cannonade, upon our sea three fronts, between the King's Bastion and the North Bastion, including the Montagu, and the Prince of Orange's Bastions. Five of their batteries were constructed upon two deckers, and five upon single deckers, in all about 144 pieces of artillery, besides from 4 to 7 spare guns in each, making 43 more, in all 187 exceeding fine guns, all cast on purpose. They were immediately answered, in full as lively and active a manner, from all our prepared batteries that could properly bear upon them, but with much more judgement, precision and execution, particularly from our redhot shot with which we plied them most amply, and efficaciously, together with our shells from mortars, howitzers, and from 24 and 32 Pr. guns, in so much, that rather early in the afternoon, we could perceive some of them, by the issues of smoke, seemed internally to be on fire, and as if some lurking embrios of fire were labouring to burst forth, which notwithstanding all their visible efforts to extinguish, two of them actually did flame out about midnight, and before daylight 5 more were on fire, and before twelve at noon next day two more were on fire, and the last and tenth was set on fire by ourselves. As by daylight the enemy had abandoned the whole, except 340 Privates, and 9 Officers, which were left behind, so that by four o'clock in the afternoon of the next day, or in about 32 hours after they drew up before our walls, this truly formidable Armada was annihilated. Seven of them, when the fire approached their magazines, blew up with an awful and tremendous explosion, to our great joy and satisfaction, particularly as they had, neither in their attack nor explosion done our works, or batteries, any very great damage comparatively speaking, for such a long and violent effort, powerfully supported during all the time of this sea attack, with a very heavy fire from all their batteries upon the isthmus, as already in some degree described.

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The expense of time, labour, materials, and money to fit out this Armada, exceeds all description, as they pretended to be so constructed and fitted out, that they should be entirely proof against shot, shells, and fire, and not to be sunk; but our well plied red hot shot, etc., etc., soon convinced them of their error, and it was perceivable, that even so early as about five in the afternoon, they began to slacken their fire, and be in some confusion at the apparent danger which seemed to threaten them. When they saw that their darling, and so much boasted batteries, with which they have so long denounced the destruction of this place, would infallibly be soon on fire, and in a little time after, some of them on board, (nay I believe a great number) began to apprehend their growing danger, and before midnight, began seriously to think of their safety, and escape, by making many repeated signals of distress, and to call for their boats, from their fleet and shore, which immediately put off and came to their assistance, and to take away as many as danger, confusion, and time before daylight would allow of, but before the dawn of day, long, our 12 gun boats commanded by Brigadier Curtis, was alongside several of them, tho' then burning, and consequently at a great risk of himself and people, brought away the 340 prisoners, and the 9 officers, who I think, but for Commodore Curtis's enterprising humanity must have all been sacrificed, for while he was alongside of two of them on fire, they successively blew up he very narrowly escaping, his own coxswain being killed in the boat.

In the attack of the 13th, we lost Captain Reeves of the Royal Artillery Adjutant, two Sergeants, and 11 Privates killed. Wounded 5 Officers, 3 Sergeants, and 81 Privates. Officers wounded, Captain Groves and Seward, Royal Artillery, Captain McKenzie, 73rd, Lieut. Whitham 58th and Lieut. Godfrey, Royal Artillery.

Our Corps of Artillery I think, gained the greatest honour that day, and the effect of the power of our three new additional works, which to my astonishment, being the points they attacked, actually taking the bull by the horns, viz. The King's, The Prince of Orange's, and the Montagu Bastions, together with their intermediate curtins, was universally acknowledged to be very conspicuous and efficacious, particularly the King's Bastion, opposite to which the Spanish Admiral and commander of this Armada drew up. Between the 10th and 11th inst. a storm of wind arose, which proved very detrimental to the combined fleet then anchored in the bay and drove upon our coast the St. Michael Spanish man of war of 72 Guns which became our prize and is got off and the crew prisoners. Several were disabled and some drove on shore, had it lasted three hours longer I suppose 6 or 8 of the enemy's principal ships of their fleet would have been on shore and behold in the evening of the 11th comes our fleet and convoy under Lord Howe. The Enemy's fleet next day went out of this bay (42 of the Line) and we expected the next morning at farthest a general sea engagement from such a manifest superiority. But to what to attribute it to? I know not, there has been no engagement; the convoy is now (18th Octr.) coming in to the immortal honour of Lord Howe in my judgement who has never been out of sight of this Rock, the enemy's 44 having had the

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weather gage of his Lordship's 34 but it would seem they did not choose to engage. Yours I have received of the 12th July, my sister's of July 22nd and August 26th, Mrs. Nicols of 17th July. Tell them all, the family and friends I am well but cannot write to them at present (18th Oct.). I approve of Charlotte's going to Mrs. Skinner's. God bless you, in the greatest of hurry farewell.

Yours most affectionately,

W. GREEN.

Finished 18th Octr., 1782.

You see my hurry in my conclusion. The Convoy come in, the Cork ships annihilated, Lord Howe master of the Gutt and Bay, and the British Colours flying upon this fortress.

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THE DIARY OF TWO NOVICES IN NYASALAND.

By Lieut. T. Benskin, R.E.

Fish and I were two R.E. subalterns in South Africa, and with the usual pleasure-loving instincts of our kind had for long hoped to murder a few big animals in Central Africa. An opportunity at last arose, and Nyasaland was chosen for the trip, of which the following is a short account, which may prove useful to others fired with the same ambition.

There are no tales of mighty slaughter and of fearful danger, or news of strange and unknown plants and life to be read, only the truthful account of how two novice big game hunters spent a few weeks in peaceful and half-civilized Nyasaland.

In August, 1910, the two of us steamed in a Castle Liner from Delagoa Bay, travelled a few miles up the East Coast of Africa and disembarked at Chinde, by the mouth of the Zambezi. There is little to tell about the journey up the Zambezi and Shiré Rivers to Nyasaland, for it is a well-beaten track, and although far from dull there is nothing much out of the common for any traveller in it. Flat-bottomed stern-paddle boats, much like those on the Nile, take one up the Zambezi, and small house boats which draw some 10 in. or so are poled up the Shiré by about eight boys. When Port Herald is reached the rest of the journey to Blantyre is done by train. One sees a few hippo and crocodiles on the river, and any amount of duck and geese, but, save for a few casual shots at the latter, there is not much to be done. Seven days were spent on the journey from Chinde.

Our plans were at that time very vague, and, with the exception of our guns and cartridges and the usual soldier's camp kit, we had hardly any luggage or stores. Everything was to be arranged at Blantyre, and we hurriedly left the sandy desolation of Chinde. But we did one useful thing at Chinde, and that was to engage a servant to see us on the way—or rather I should give Fish the credit for that action. George was generously engaged as a servant by Fish, not for himself but for me. He seemed a curious creature and he called himself a cook, but it did not take long to find out the truth about him and to learn that he was in reality only a savage "Yao," who was posing as a servant in order to be taken home again up country. Still he had his good points, and when all other means failed George

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could easily open a tin of hermetically sealed cartridges with a single bite of his ferocious teeth, and he washed clothes with a zeal which would certainly excel that of a Parisian laundress. In fact his cleanliness got the better of him for he continually washed clean clothes as well as dirty ones, and he had an unpleasant habit of thinking that it was also his duty to wash me. At times he reminded me of my garden boy at Pretoria who, when told to water the garden, commenced by watering the water-lilies in the fountain.

Anyhow everything on the journey went off very well, and at the end of August we found ourselves comfortably asleep in the African Lakes Boarding House at Blantyre.

Thursday, 1st September.—The town on first arrival seemed rather a jumble of a few scattered buildings amidst steep hills and trees of every kind. Blantyre is the civil centre of Nyasaland, but Zomba, chosen for the better climate and situation, is the head of the administration where the Government headquarters and troops are collected. In the morning a call on the District Resident at the Boma, and the presentation of a letter of introduction, resulted in our obtaining our licences—£30 each with a signed bond for £20 in case of infringement. In the afternoon we gave our lists of stores to the African Lakes Company where a companion on the Zambezi had given early warning of our arrival and needs. The Company have fixed their headquarters at Blantyre, and the outward appearance of the building resembles a fort rather than anything else. In early days I suppose that it was a fort, but its native name Mandala—meaning eyeglass—is more suggestive of peaceful old Scotchmen wearing spectacles, than of the ruthless hordes of natives bent on loot and the murder of those first inhabitants. Camp kit, tents, guns and cartridges had been brought with us, but everything that was likely to be wanted might easily have been bought or hired at Blantyre, and at a far cheaper cost than we had got them in the Transvaal. There are several excellent stores ; and, when men leave the country, sales at which good rifles and cameras can be picked up for a few shillings. We were advised to use grass-soled canvas shoes, at 2s. a pair, when hunting, instead of our imported heavy boots, particularly as we were going to bicycle whenever possible.

In the evening we all dined with the Resident in his very comfortable house, going to, and luckily fro, by rickshaw. Much valuable advice was given as regards both sport and natives, and our host said that he hoped to provide us with a good boss boy, or capitao, who knew some English. That evening it was settled that we would do without the nursing of any white man. For when at Chinde we had been sorely tempted to place ourselves in the hands of a professional hunter, but the idea of having some stranger as companion to run the party had never seemed pleasant, and such an arrangement would have

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been far more expensive, and also destructive to all experience and much amusement. One can only learn by doing things oneself. We made up our minds to engage Mandala boys to take us quickly as far as Chikala—east of Zomba—and there to re-engage our own bearers, or tenga tenga, with a view to working north-east and awaiting events.

Friday, 2nd September.—In the morning the Capitao, John Mahommed, promised by the Resident arrived with some 10 followers and proceeded to take advantage of our innocence in every possible way. All of the party were picked boys, all of them experienced trackers, cooks, warriors, servants, and strong men, and all of them needless to say accustomed to receive double the normal wages of the land. John certainly did seem to fulfil his own description of himself, and he was not far wrong when he said that we should find him to be a most "intelligible" person; he spoke English fluently. Luckily it was evident that our eagerness to collect our staff was only equalled by their desire to be engaged, all questions of payment were airily postponed and the services of six of them provisionally accepted. John was to be taken as Capitao, James as Fish's personal servant, (I was already saddled with that curious individual George) and Wilfred as cook, with an assistant in charge of water, leaving Kokwana and Simbota, two normal natives who were to act as gun bearers. Thus we were only in need of two good hunters whom we hoped to obtain from Liwonde and to find waiting for us at Blantyre, in addition to the common carriers or tenga tenga. The Mandala would provide us with the latter as far as Chikala. Conversation when at dinner with the local Judge put us in the right direction as to wages, so John was severely spoken to, and the slightest reference to the magic word "Boma" (police court) was sufficient to make him sensible. Our loads were checked, a second bicycle bought (Fish had brought his old jumble of iron from South Africa) and we were ready to start at daybreak.

Every day one realized how much of interest was missed by failure to understand the Chinyanja language, and a good interpreter seemed essential. Natives are wonderful at picking up languages and George could already speak a few words of English and understand more. At moments he would break out into a long sentence, and whilst putting me to bed that night he suddenly with a loud laugh made two important announcements:—Firstly, that the Bwana (white man or master) ought to go to school, and secondly, that John had been making a fool of the Bwana. Perhaps in some respects it was lucky that we were so ignorant, but we bought a book of the language the next day.

Saturday, 3rd September.—From Blantyre to Zomba, a distance of 42 miles, the road was excellent and very pretty, amidst hills covered

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with slender close-growing trees. It was being straightened and improved by good metalling when we made the journey and was fit for a motor car throughout. There are several motor bicycles and two or three motor cars in Nyasaland. Almost every white man has a bicycle, but the usual means of travel is in a Machila—a kind of hammock—carried by two or four trained boys with about twelve others in relief.

When in a Machila, the great tip for comfort is to have plenty of cushions under one's knees. Personally I found it the most uncomfortable means of locomotion that I had tried anywhere for a long journey. But on that occasion we bicycled, outpaced our bearers of course, thought we had lost them and were only rejoined at Namadzi, a distance of 22 miles from Blantyre. It was just getting dark and the boys did not know how to put our tents up, or where the food was, so we decided to try the hospitality of a neighbouring settler who owned an immense cotton estate close by at Magomera.

There seemed to be an unwritten law in Central Africa that hospitality is to be given by a resident to every passing white man whoever he may be. Certainly I have nowhere in this world found such a continuous open-handed welcome. It was difficult to feel that this hospitality was not being abused, for nowadays Central Africa is really well known and easy of access ; travelling and shooting parties stream through country which has only been opened up for a few years, and every novice sportsman with a string of questions in his mouth visits the unhappy settler, missionary, or civil servant, and receives a splendid meal with priceless wines and cigars. Also it must be remembered that Central Africa has its tramps like any other country, and one finds amazing men, known as D.B.S. (distressed British subjects), who have wandered as beggars with only a kaross and tin mug on their backs from village to village through the very heart of Northern Rhodesia. Certainly a visit from the outside world may be a thing to be valued by these generous gentlemen, but they must receive too many visitors, and the hospitality should to my mind be first offered by the pleasure seeker who can afford time and money for a big Ulendo of 60 boys with tents and stores. As usual we were given a splendid welcome, and beds which were on this occasion accepted with alacrity.

Sunday, 4th September.—The difficulties of the previous evening had taught us the necessity of passing a quiet afternoon playing with our tents and finding the way about our dozen boxes full of tin pots, stores and food. Camp was pitched at a pretty little spot called Ntonbwe, where a passing white man visited us. He had heard of our coming and brought news, good and bad ; firstly that from Chikala we should get good sport, and secondly that the hunters, or elephant professors as he termed them, whom we were hoping to obtain from Liwonde were already engaged.

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That afternoon we overhauled our guns and did a little target shooting, for there was no game in that part of the world. We each had double-barrelled ·470 cordite Express rifles, Fish a ·303 sporting carbine and myself a ·256 Mannlicher. The sound of the shooting alone was enough to attract several natives, and three boys volunteered to join us as porters straightway.

Monday and Tuesday, September 5th and 6th.—After an 11 miles ride we reached Zomba. An introduction to the Acting Governor resulted in our obtaining permission to shoot one bull buffalo and one bull eland apiece, animals which were already protected in Nyasaland although they abounded. We also obtained some quite good maps which did not however prove to be as useful as they might have been, being for the most part blank for the districts which we hoped to visit. As we had not come to Nyasaland to visit Zomba but to shoot, we disgusted our boys by pushing straight through the same day, and spent the night near a village named Niezi, 5 miles out of the town.

A 24 miles ride the next morning took us to the foot of Chikala Mountain, where on the side of the hill there stands the boma with its wonderful outlook over Lake Chilwa and across miles of burning bush and dambo, right up to the slopes of Mount Mlanje. The boma man and his charming wife had heard of our probable arrival and gave us the usual welcome, a hearty lunch and dinner and immediate assistance by collecting 45 boys for our loads. Within six hours we had dismissed our Mandala porters with cash payment and were ready to go on with our own private and personal tenga tenga. Each boy was registered at the boma to receive 4s. a month wages and 1s. as poso (money with which to buy his food), and the actual payment was to be made in limbo (drab-coloured cotton), coarse salt or cash according to our convenience. The climb up to the house had been very trying from the heat, and we were still very soft after the lazy time on the Zambezi, so much so that Fish got touched by the sun and we both found it necessary to add puggarees to our double Terai hats.

At Chikala the good track ceased, and that day for the first time we realized that we were approaching the haunts of game and nastier things; for on seeing a beautiful mauve-coloured flower with a curious furry red bean I had picked a pod with the hope that it might grow elsewhere. Old inhabitants know the dangers of the Mucuna bean, and so did our boys to judge by their grins. Within five seconds I was wildly scratching at hands, arms, face and everything in vain trying to rid myself of this wicked pest which causes the most maddening irritation, whilst the gentle Fish sat down and laughed and concocted plans of sending pods home to his country pals. Again, in the evening when departing in the dark to climb

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down to camp, some mile or so away, we were calmly told that it might be advisable to take a gun, most certainly a lamp, with which to keep the lions away. As I had been scared out of my wits in broad daylight when close to the house by a huge baboon jumping up two yards away from me, this was not comforting. We performed the most silent night march ever walked by soldiers. Luckily for our fears the lions only "noised," as John termed it, at the next village.

Wednesday, 7th September.—From Chikala to Pankande was a short journey of only 12 miles, but sufficient for that day as we wished to get our string of strange boys under control. Being still without any proper "hunters," we were very glad when two most savage natives appeared to offer their services. Wyedi and Ndala were splendid-looking fellows with neat little beards and long slender agile bodies which made them appear fit for any work. We gave them each a hunting knife and sent them on ahead to look for game. Cheap hunting knives with leather sheaths and soft metal blades had been already given to the two gun-bearers and to John, who was also very superior in our gift of a new shirt and trousers of khaki. A funny little piccanini 4 ft. high was very eager to come with us, so he was christened Leetlejohn or Johnnylei and made carrier of the butterfly-net.

The Ulendo was a delightful sight and the novel joy of travelling in such fashion alone worth our long journey. Two boys chosen for fleetness of foot were detailed as Jinga (bicycle) carriers and were made to run in front of Fish and myself. Their work consisted of carrying the jinga on their heads when the track was too bad to permit of riding, and shouting out warning when some impossible twist in the path or a fallen tree was liable to destroy us; the warnings were usually forgotten. I suppose that they were useful in this latter duty, but we soon grew so used to taking headers into the bush that we never even paused to sympathize or comment on our falls. Native paths are like the native's mind and unable to lead direct to the point; they are narrow, and twist off in an entirely new and strange direction every few moments. With perseverance the object in view can be reached. The jinga tracks served as a great inspiration and beacon to the weary carriers behind us, but if any doubt were likely to arise at some cross paths the smallest hint, such as a couple of leaves or a small scratch in the dust, equivalent to our English signpost, seemed sufficient to keep the boys in the right direction. The two gun-bearers came behind the bicycles, keeping up as best they could and seldom outpaced. We soon gave up all thought of shooting while on the move and decided to reserve our energies until arrival in camp.

When leaving Blantyre we had feared that some of our loads

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might hardly prove, from awkward shape or bulk, exactly convenient to be carried. However, we quickly learnt how groundless were our fears, for a native can balance anything from 30 to 50 lbs. weight upon his head. Leetlejohn always headed the bearer party brandishing his butterfly-net and with his own small sack of flour upon his little head. The sack had usually a small hole in it and Leetlejohn was a fearsome sight when turned from black to white. Next there came my priceless "tinbockus" containing all the money, books and medicine, but nearly always with a poor live nkuku (chicken) hanging by one hapless leg from the handle; and then the long stream of ever-chattering smiling jesting tenga tenga, ready to break into a run and curious bell-like tra-la-la-la cries at every sight of the bicycles. They were delightful people. A crowd of happy children; a smile and they would crow with joy—a frown and vanish in the bush.

The personal staff followed in rear as whippers-in; first James and George, the two valets; James, a sly obsequious young rogue with a little mission-taught knowledge of English and worse things; George, a natural enough villain of huge muscle and a fighting instinct which rather detracted from his value as a body servant. With his first wages he had bought a blue-and-white striped vest which shrank and only reached some 9 ins. below his shoulders. This and a pair of knotted legs protruding from a close girt loin cloth made George the most extraordinary spectacle conceivable. Our cook was moderately old and liked to wear a long blue toga; but when this cloth was tightly wrapped around his waist and legs, and Wilfred walked with a neat cane in his hand and a new grey felt hat on his wrinkled face, he then became a thing that was indeed strange and ludicrous. In his own language he was a great conversationalist; luckily he could not talk English sentences, but much wandering had taught him many oaths not understood, I hope. Having a nature that was inclined to explode into frantic excitement if even addressed, he made a splendid whip. He also proved to be an excellent cook, but one best left alone, for even a smile would make him suspect some interference with his power as autocrat of the kitchen table. We called him "Her" and "Mother" Wilfred. Last of all was John. Well, John was John, superior, quiet and reserved, a most "intelligible" person—but ready to break into bursts of suppressed savagery which were truly awful in their heartwhole sincerity.

Thursday, 8th September.—At Pankande we made our first attempt to kill big beasts, and on arrival spent the evening at a useless search for kudu. The grass had not been burnt and we only saw spoor; and that was all that we found in the morning as well, if one may omit the discovery of a huge flat beetle in my trousers. Bad water and

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long grass made us decide to move early. Chinyanja, only seven miles ahead, was the next camp, and by 10 o'clock the tents were pitched close to a native plantation of casowa and castor-oil plants, both favourite foods of the kudu.

At Chinyanja there is a reedy lake, whose outlet flows into Lake Chiuta. Ibis and a few storks were visible on the water, no duck or geese. Kudu were said to be close at hand and we meant to go for them in the evening, but tales of mvu, (hippo) and of mvu on land, were brought to us so we started off at once. The hippo was by then in the middle of the lake where he had probably been the whole time, but very visible, so we dived into some reedy swamp up to our knees, till we reached the deep water's edge, during which time of course the hippo sank. For nearly an hour we only saw a few crocodiles' snouts close by—till suddenly on the far side 150 yards off two big hippo came through the rushes. We both fired our ·470 solids and each hit hard. The bull plunged head over heels into the reeds on the right where we heard the poor beast grunting in pain, the cow also tumbled right over and into the water where she disappeared. John promptly went off his head and all the savage burst out to be quickly repressed again. His heartfelt cry of "Oh ! Bwana, Bwana,—plenty nyama to-night and plenty fat," proved incorrect, and after a long wait and rather timid search in the reeds where the water luckily got too deep, we went back to camp, thinking hippo shooting rather an unsporting amusement. One should not shoot unless certain of killing, and the hippos are nice pleasant old creatures, big friendly pigs, with no desire to hurt people except when protecting their young. They may perhaps eat up a few acres of native lands in a night, but the wise landowner will always scare them away by making his piccaninis shriek all night from the dubious safety of a slender shelter some 10 ft. high.

In places the lake was covered by a peculiar mat of broken-down reeds, which might just carry one's weight. It did not always, and Simbota just got me out of the water in time, whilst Fish hindered him by trying to take friendly photographs. The inhabitants were delighted at our wade into the water, a thing no other white man had been fool enough to do before, and that evening the Chief visited us with the usual "presenti" of a chicken for which he received a "presenti" of a "tikkey" in return.

Friday, 9th September.—We were beginning to consider ourselves to be rather failures as sportsmen. Every morning the two valets had overslept themselves and had been soundly abused for waking us up at about 6 o'clock. It was rather noticeable that Fish's chides were never disclosed before lunch time. That morning the servants avenged themselves by telling us at 2 o'clock in the night that Wilfred was cooking the breakfast, a mistake which Fish only found

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out at some later hour, when sufficiently aroused for him to realize that most of his clothes were on and that I was again asleep. Those next two hours in bed were very pleasant.

That little episode made us realize that all of our boys were completely lost as to time as soon as the sun, their clock, had set. We had quite early on our journey understood that they never had the least idea of distance, and their abominable politeness was always the source of trouble in that respect. The answer to any question always consisted of the reply which to their minds might give the most immediate pleasure, and often did we wish that a wretched word "pafupi" meaning "near" had never been invented. The reputed skill of the natives as guides in the bush was disappointing, but opinion based on such slight experience as ours could hardly be considered. We found that it was certainly advisable to have a local villager with us, for he would always reach his destination somehow, and his presence gave one a sense of security, but seldom was our patience sufficient to silently undergo the usual exhibition of the homing pigeon tactics, or to view without comment a final cast taken in an obviously wrong direction in order that the continual twists might bring the leader right. We even began to suppose that this perverted bump of locality explained the nature of those extraordinary native paths which caused us so many a painful fall, and refused to accept the simpler reason that the first track naturally twisted to avoid fallen trees and clumps of thick bush. At night I certainly think that we had a better idea of guiding than the natives, for, as soon as it grew dark and the strange secret sounds of the bush commenced, the poor fellows became quite useless and their every thought was hushed to a quiet longing for bed in safe companionship or for the sham bravery of a moa-spattered tom-tom.

When we did at last get up and try to shoot, Fish was the person who proved to be most awake or who at least pretended to have been. John was sent on ahead with the Ulendo to fix up the camp at a place that owned the cheerful name of Mtalala, whilst we two sportsmen went in different directions, for after our early rouse a separation seemed particularly advisable. Having spent 3½ hours pleasant wander through pretty country where the young shoots were bursting up from the burnt grass and where one only saw the spoor of kudu and eland, I returned to meet Fish at Chinyanja. There he was found waiting for me, and his ill-concealed excitement and impatience made it very clear that something unusual had taken place. After a few casual remarks about the heat, his thirst and the general lack of game, he tried with rather exaggerated unconcern to break me the news and left me utterly fogged as to what had happened; but after cross-examining him with the same method that one would apply to a native, I managed to elicit some small amount

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of truth about his achievement. Being annoyed with the previous day's amusement and with hippo in general, and also no doubt still half asleep, he had fired a shot with his ·303 at about 500 yards range and out of mere malice in the direction of a harmless creature whose eyes were just sticking out of the water. The hippo had as usual sunk; Fish had then wandered on into the bush where he of course failed to hit anything, returned to the lake to see if he could harm any more gentle mvu, and there to his surprise had found his target of the early morning floating upside down swollen to an amazing shape in the middle of the lake where it looked like nothing earthly. I promptly claimed the beast as mine and as the one which I had knocked into the pond the previous evening, but unfortunately the sex proved to be wrong. The whole affair was most unsporting. And it was thus that "we" killed our one and only hippo, which provided us with all the hide and teeth we wanted.

A boy was sent to recall John whilst we wondered if we could with safety salvage the beast before it burst, and it was decided that we could not, but that the friendly Chief who was surrounded by the entire male portion of his clan, might be able to do so. This caused intense excitement and about an hour's unintelligible conversation, during which all the women and children were collected to watch the operations and encourage their guardians. After considerable persuasion some twenty braves began to modestly unrobe and went into the water up to their knees, thought better of it and tore back to shore for further stimulation by singing a song for half an hour. At last they tried again and reached the dead animal which was only in about 5 ft. of water, and they there began to smack it. This also proved to be too much for them; they again rushed back to safety on land and began to smack each other. Things were growing tedious so we threatened to withdraw our promise of nyama, and at last to the sound of many a song and long-drawn cry of Mvu the dead beast was dragged on shore.

John only returned at about 3 o'clock when he was in a very bad temper and said that he and all our boys were Mohammedans and would never think of eating so foul a creature as a hippopotamus, that he thought it rather silly of Fish to have killed a docile hippo (I agreed), and, in addition to much other chat, that the person whom we had thought to be a chief was not a chief at all but only a pedlar of chickens. We offered to kill him another mvu in correct Mohammedan fashion by first cutting the throat but he would not be satisfied in any way, and continued to be so communicative on native and his own habits that we decided to keep him in a bad temper for all time. So we told him to distribute the meat to the villagers whilst we tactfully returned to our tents, where Wilfred was shrieking, and George met us with a swollen mouth and tales of John having been a wicked

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man who had fought the Tenga-Tenga and personal staff for several hours on end.

Later in the evening Ndala suddenly appeared in the opening of the tent. Ndala was full of talk and other things, big tales of countless game to be found at Mtalala, a present of two chickens and some eggs which we were supposed to pay for, more chatter of the fight with the Tenga-Tenga which had taken place at his home, and worst of all—moa (native beer). The word "presenti" was becoming ominous, and it was dawning upon us that these savages were not the open-hearted generous gentlemen that we had at first been led to suppose them to be by their charming and hospitable manners; already our Ulendo was developing into a travelling menagerie of nkhuku, and the continual stream of such gifts appeared to suggest that our followers were not only avaricious but thought that chickens would be the sole creatures we could kill and eat.

Saturday, 10th September.—Most of the Mohammedans were ill. Also Fish, which made one wonder if he were a fit companion for a Christian sportsman, but he reassured me by asserting that the pain was confined to his foot. Anyhow we managed to get clear of camp at 5.30, at far too late an hour, and started off together in the direction of Mtalala, walking through endless villages and patches of cultivation.

A bearer behind us first saw game—a brief glimpse of a kudu—so we divided up with the idea of getting the animal in between us. After a little stealthy creeping, the two leaders, Ndala and a villager, who had joined us nominally as a guide and in reality because he was hungry, began to visibly stiffen and then carefully point into a clump of trees and long grass. A very steady and intent gaze in the same direction produced nothing out of the common, and after two minutes it seemed that some native jest was being attempted—but sure enough there slowly began to shape amongst the branches and grass the motionless head and curling horns of a buck. With great precision I aimed, fired, missed, and in one quick moment realized how untrained I was and how little I had seen in that bush, for at once and all around me the country seemed alive with brief flickering glimpses of startled kudu. Then began more quiet hunting and more flashes of movement ahead through the close trees, until one curious creature—a cow—calmly climbed on top of an ant-heap 120 yards off. This time I hit, knocked her over, rushed up to the ant-heap and there found nothing; but she was easy to spoor and a few minutes later with a grunting bark which frightened me so much that I forgot to shoot she got up 20 yards off and was again away. However, a running shot from on top of another high ant-heap again knocked her over; the savages gave a howl and dashed off in pursuit, easily outpacing me, and when 10 minutes later I joined them I found a fair-

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sized group, which strange to say included Fish, gathered round my first real kill in Nyasaland.

Fish's congratulations were disappointing. It would have been useless for him to have made any claims on the animal, but it seemed an unnecessary action on his part to utter some remark about my always having a tendency for a lady, but doubtless he was feeling hurt at the manner in which this one had only troubled to go even near him when driven away by me and when dying. The hungry villager who had made some dozen death thrusts with his spear entreated us for a gift of nyama and great was his elation on being allowed to eat the head, which the Mohammedans had quite spoilt as a trophy by slitting the throat from ear to ear. One's boys should always be warned to only punch a hole in the base of the neck where it joins the body, thereby satisfying their religious scruples without damaging the skin which one might wish to have set up.

After a 9 miles' walk we reached Mtalala and, after hearing the reports of our scout Ndala, imagined that we were at last going to find ourselves in a place that could be termed quite rotten with game. The village was on the south-eastern side of the large dambo which lies between Lakes Chilwa and Chinta, and we stepped from the comparatively close forest of small trees on to an open plain. At that time of the year the grass was not all burnt, but the ground, which in the wet season must be mainly under water, was quite dry.

In the evening Ndala led us out to the prairie land where according to his tales buffalo and all kinds of game were to be found; but we only found some two days' old spoor and saw one or two hartebeest, and a few reedbuck who whistled at us from a distance. After some ineffectual shots at too long a range we retired to camp, accused Ndala of being a liar who had enticed us to his village home in order to get rid of the family chickens, decided to move on again the next morning instead of staying in the would-be paradise of sport for five days, and went to bed very tired and rather grieved with life.

Sunday, 11th September.—We were told that a place named Nabwasi, in the middle of the Dambo and 12 miles to the north, would be a suitable camp for that night. The Tenga-Tenga started off straight in that direction, whilst Fish branched across the Dambo with Wyedi and two bearers, and I went with John, Ndala who was still kept with us on trial, Simbota and one boy along the eastern edge.

For two hours we walked through the bush and only saw a few gwapi (small buck) and one hyæna, until at about 9 o'clock Ndala climbed a tree to scan the Dambo and said that nyama were in sight

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far across the plain. The grass was fired and we at last came within reasonable distance of a big herd of zebra, wildebeest and hartebeest grazing where the grass was short. There was very little cover but, after a long stalk, a successful shot killed a good-sized hartebeest, who with the usual folly of his breed had let his curiosity get the better of him. After leaving two boys to bring in the nyama, the rest of the herd was then followed with the hope of getting a zebra, but there was no cover and the beasts were too wary. One found it very painful work when crawling over the burnt grass, and I gladly remembered the tip which had been given me at Blantyre, to stalk not on hands and knees, but on the part of one intended to be sat on and to suffer pain, whilst one worked forward with hands and feet with the rifle in one's lap. When thus sitting it is easy to quickly drop flat on one's back if sudden cover is required, the rifle does not get so fouled with dirt and ashes, and the game can always be kept easily in sight.

Presently the boys found some new buffalo spoor which they said was only two hours old, so of course we followed and I watched some delightful tracking. A glance at the broken grass made the age evident to them, and their estimate was subsequently confirmed by our finding some dung and even a praying-mantus, crushed by a hoof yet still alive. Ndala whilst gently following the tracks suddenly stopped and pointed out a fine sable bull looking square at us through the grass, but apparently it was quite unscared and only watching out of curiosity. Slowly the rifle was brought up to my shoulder and just as I pressed the trigger the beast vanished. A moment afterwards and all our Tenga-Tenga appeared round the bend of grass, shouting and singing under guidance of Mother Wilfred's terrible chatter of curses. It was a great chance lost, but anyhow the njati (buffalo) spoor was still there and ready to be followed with still greater zeal.

In about half an hour it led us to a belt of thick grass 8 ft. high into which we dived, John, Ndala, myself and then Simbota with the guns. Suddenly the two leading natives became wildly excited, the buffalo were within 500 yards they said—probably sleeping, so I bravely seized the 470, loaded the Mannlicher with solids for John, and much against my will went on ahead. Again we crept on through grass in which it seemed utterly impossible to find anything. Excitement grew greater—till John whispered that they were asleep and only 20 yards off. "Plenty njati, Bwana, plenty. Bwana will go on and kill them all, but first the biggest." That seemed pleasant for a novice who had never even seen a buffalo in his life. But hesitation was quickly settled by a rush of John straight past me and I was left to blindly lumber after him in a wild scramble for 300 yards, trying in vain to keep the bounding nigger

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within 5 yards and in sight. I was gasping for breath when at last he stopped. The grass just there was a little less impenetrable and 30 yards ahead two shadowy forms were dimly seen to disappear. John was furious—with me I suppose—but I had the better of him for 20 yards on my right two more were visible and I quickly snapped at the biggest before John had noticed them. The heart shot was vaguely remembered and aim was taken through the grass at where the target might have been. With a howl John again dashed on and we were tearing after frothy blood spoor through the thickest grass yet seen till we came to a bare spot hardly 10 yards square, where I panted Pola-Pola—"gently"—to gain breath, and where even John also seemed for the moment willing to stop. Apparently it was "a plenty bad place," and "plenty njati were waiting" for me. But the wretched native with a return of breath once more saw red, all caution became lost in his mad desire to kill, nothing would stop him; and false shame alone made me follow till I found myself emptying both barrels at a huge body which seemed to rise on the right 3 yards off and just too late to reach us. He was a magnificent bull, and we were all wildly delighted. John, completely calm again, tersely summed up the situation by saying "Bwana has chance."

The whole scene was traced over again and spoor marks showed that the bull whom I had hit with the first shot just behind the heart had been one of a herd of 13. John disclosed the secret of what had seemed to me to be his wonderful knowledge of the beasts' movements by saying that he had seen above the grass not only the white tick birds who always accompany buffalo, but also some quite small dark birds who hovered immediately over the animals' backs and must have woken them up. The animal had turned round about 30 yards in his tracks before lying down and had been waiting for us. A knot was tied in the njati's tail to make sure, according to belief, that when eaten he would lie easy, and Ndala was left in charge. On the way home to the camp a herd of 15 sable was passed, but I failed to get the one good bull amongst them.

Nabwasi turned out to be a small rocky hill with a muddy pool at the foot, and from the summit there was a wonderful view over the prairie-like Dambo fringed in the far distance by trees and hills. Fish was already in camp waiting for us, and he produced as his share for the day's kill a fair reedbuck bull and a cow—no mean addition to our suddenly swollen larder. In the evening we had to comply with custom and superintend the cutting up and distribution of the nyama. Knock-kneed John crept up and down in the twilight purring like some foul ghoul over the piles of meat, whilst the 60 boys stood impatiently waiting for their shares. For the first time in my life I really heard human beings licking their chops. Some had

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even been trying to steal huge chunks which they ate raw. Finally each boy having received his slice of meat, a few short words were given and all the mob rushed fighting for the few remaining scraps—gnawing and singing as they tore at the little bits. The camp was happy that evening, and all night long one heard sounds of gorging. Amidst such a shambles and with such a smell around one, even tinned fruit seemed unpalatable. Personally I had had my fill of excitement for the day, and went to bed most forcibly remembering the warnings given me by friends—never to follow a wounded buffalo into long grass.

Monday, 12th September.—That knot in the buffalo's tail did not appear to have been of much use. Powerful as the precaution may have been it could not make 30 lbs. of meat lie easy. Fully half of the boys were suffering and had a distinctly swollen appearance, but little John was the most extraordinary sight. He was perfectly fit and cheery, but looked exactly as if he had swallowed whole an entire water melon. The tin bockus was opened, the medicine chest produced, and every sufferer given an enormous dose of Epsom salts.

It was the first time that we had posed as doctors and as soon as the boys saw that we were prepared to cure their ailments we found ourselves faced by about a dozen patients of every sort. The medicine chest was rather a shabby affair but it contained the right things. Two kinds of pills, some tooth and eye mixtures, phenacetin, plenty of quinine, permanganate of potash and yards of bandages were kept in a biscuit tin. We also had a pocket syringe for injecting morphia and other drugs, a huge tin of Epsom salts, some boracic powder, a sharp knife and a pair of nippers. Most of their troubles were due to cuts in the feet, and there were some very nasty places, so we gave orders that every Tenga-Tenga was to make himself some hide sandals, and we applied the same cure to every case. Each boy had to produce some clean water; with a few mystic words some grains of permanganate were dropped into it and the water turned pink whereby the cure was already nearly complete. Then the wound was thoroughly cleaned—boracic powder rubbed right into it—if it hurt we said that it was because the pain was all getting used up, a bandage was put on to keep dirt out, and the patient who had previously shown no signs of lameness went off quite seriously with a powerful limp. A bandage seemed to be considered as an honourable decoration, and one boy who had no trace of hurt or pain asked for one.

It was much the same with a very bad case of toothache. Some cotton wool was soaked in the mixture and applied to the tooth, the boy was told that this medicine which had been given to me by a great white lady, was the finest in the world, and he never

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complained again. He kept that wool in his face for quite five days and most probably has it still stowed away somewhere with his snuff pouch.

Fish also was ill on that morning, and again maintained that the pain was only in his foot, so we spent the whole day in camp as a rest day. There was not much rest about it as all our kits needed to be sorted out and the heads to be cleaned. The two doubtful hunters Ndala and Wyedi were sent out to locate game and we confined our sport to flinging out bits of meat to attract the marabou and potting at them with our rifles. I got one but he had poor tail feathers.

(*To be continued*).

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AN ENGINEER OFFICER UNDER WELLINGTON IN THE PENINSULA.

(*Continued*).

(*Edited by* COMMANDER THE HON. HENRY N. SHORE, R.N., RETIRED).

Coimbra, Sept. 29, 1810. Went from Bolao to Fornas to find Col. Fletcher ; dined there with Lord Wellington and Marshal Beresford ; the former gave me a letter for the Col. which I took to Coimbra in the evening. Head Qrs. were at Coimbra on the 30th. Next morning,—" suddenly, obliged to leave Coimbra at about 8 o'clock ; the roads crowded to excess with fugitives of all ranks, ages and sexes ; Head Qrs. established at Condexa ; soon after, ordered to proceed to Redinha, where we arrived by the evening."

Oct. 2. *Leiria.* Marched with Head Qrs. from Redinha ; roads crowded with inhabitants from the country we retire from.

NOTE.—The enforced migration of the inhabitants entailed appalling distress and confusion, and, naturally, hampered the movements of the troops. The misery, indeed, caused by this exodus far exceeded anything witnessed in the course of Sir John Moore's retreat on Corunna ; and, with the arrival of Wellington's troops at Coimbra a climax was reached. The sufferers, be it remembered, too, were peaceful citizens, who, the year before, had welcomed these very troops with frantic enthusiasm as their deliverers ; but who now beheld them, flying before the victorious hosts of the great Napoleon. The horrors that were crowded into the next few weeks have, probably, never been exceeded. Even our own historians have felt compelled to gloss over the sickening tale. Nevertheless, we may obtain a fairly adequate notion of the scenes enacted along all the roads converging on Lisbon, by a search through the masses of long-forgotten war-literature, wherein, amidst much that is of purely antiquarian or professional interest, we, ever and anon light on descriptions which, for realistic power and gruesome interest, might vie with the word-paintings of some of our most accomplished " war correspondents " of the present day. A perusal of the pages of Napier, Lord Londonderry, Tomkinson, and others would prove a veritable revelation to those of our countrymen who are prone to regard the Peninsular War as a mere record of British military exploits, without attempting to realize the frightful sufferings that struggle entailed on the innocent inhabitants of the land.

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Leiria. Oct. 3. The troops plundered this place dreadfully; some of those taken in the act, hung directly; the inhabitants having all fled.

NOTE.—These acts of plunder drew from Lord Wellington the following General Order:—"The Commander of the Forces is concerned to have been under the necessity of carrying into execution the determination which he has so long announced, of directing the immediate execution of any soldiers caught plundering. Two soldiers, a British and a Portuguese, have been hanged this day for plundering in the town of Leyria. He trusts that this example will deter others from these disgraceful practices in future. The troops are well fed and taken care of, and there is no excuse for plunder."—LEYRIA, *Oct.* 3, 1810.

Alcobaca. Oct. 5. Marched with Head Qrs. to this place; found the houses quite deserted; procured a good qrs. Light Division occupy Batalha.

NOTE.—As this was the last occasion, on which the monks of these two splendid Monasteries—Alcobaca being one of the richest in Europe—were able to dispense hospitality to British soldiers, before suffering destruction and shameful sacrilege at the hands of the invaders, the following quotation from Capt. J. Burgoyne's Diary will be acceptable:—

Oct. 3. "At Batalha is a very large and rich Convent of Monks. The whole British Regts. of this Division (Picton's) were quartered in it easily; as well as the Generals and many other officers. Several Divisions of the British Army had, at various times, passed thro. this place, and some remained several days, during all which time a dinner was prepared at the Convent for the whole of the officers. On this day (Oct. 3, 1810) it was done for the last time, at least for the present, for the greater part of the Friars had already left the Convent, and the remainder quitted it this evening. They had had a ship prepared at St. Martino, for some time before, to take them off with their plate and most valuable effects. They leave a quantity of hay, straw, vegetables, etc., which they beg the General to distribute, as if not, the French will have it."

Junot, and his soldiers—whom we conveyed back to France, in British ships, under the terms of the Convention of Cintra—had already skimmed the cream from the Church treasures of Portugal, and thus given a pretty plain inkling of the sort of treatment to be meted out to ecclesiastical property, in future.

Returning to the Diary:—

Oct. 6. Marched with Head Qrs. to this place (Rio Major). Delancy procured me a tolerable Qrs.

Oct. 7. Marched alone on a foggy morning; got a good Qrs. on the hill at Alemquer.

Oct. 8. Ordered to Arruda in the afternoon; a very wet march; my baggage pony left on the road.

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Oct. 9. Very rainy; Lord Wellington went to Torres Vedras. Good Qrs. (Arruda) abundance of grapes and wine.

Oct. 10. San Quintana. This is the most miserable village we were ever quartered in. Rain continues.

NOTE.—The Allied troops were now taking up position behind the Lines; a few words of explanation with reference to this movement, and the state and condition of those great defensive works, may therefore prove acceptable. And first, it may be well to draw attention to the secrecy with which the labour on the Lines had been carried on,—over a great extent of country, and during a period of eleven months. True, silence with respect to the nature and extent of the works was strictly enjoined on all engaged; and, with the exception of a bare notification in certain English Newspapers, early in 1810, that men were employed in fortifying the position, no further information leaked out. Yet, as Southey justly remarks, the circumstance of works of such magnitude and importance having been commenced and perfected without attracting the slightest attention during their progress is without a parallel in history. To the present generation,—with its hordes of "Reporters"—intent on getting "copy" by fair means or by foul—the keeping of the secret must seem incomprehensible.

Napier tells us that "only vague rumours of their existence" reached the bulk of the English Army; and that neither the Portuguese Government, nor the British envoy, knew their nature; they imagined the entrenchments round Lisbon were the Lines. It is possible that, had Wellington's officers being better informed on the subject, there would have been less despondency with respect to the issue of the campaign. The works, when completed, consisted of three distinct lines of defence, of which the second was the most important and by far the strongest; the first being designed merely as a sort of advanced position to stem the tide of invasion while the Army was taking post on the second without hurry or confusion; while the third was a mere place of refuge, to cover the point of embarkation at the Tagus mouth. The determination to abide the attack in the first was an after-thought.

During the last few months, work on the Lines had been pushed on at high pressure; with the result that, on Oct. 6, just previous to the arrival of the advance-guard of the army, the Superintending Engineer (Capt. J. T. Jones, who had been left in charge of the works after Col. Fletcher joined Lord Wellington at Celorico) was able to report that "every preparation for an instant defence of the lines is now complete, and you need be under no apprehension for our credit, even if the enemy attack as the rear division enters the works . . . the powder is in the cases to load the mines, and the officers, each in his own district, is prepared to meet the divisions. . . . Now everything is in confusion; the people are all running away; and a string of men, women, and children in cars, on animals, and on foot,

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are crowding every road to Lisbon. No one will believe that the army will halt till it reaches St. Julian's (at the Tagus mouth) and all authority and order is beginning to be lost."

The following saying had been current, for some time past :—"The Portuguese are for the land, the English for the sea!"

How suggestive is the concluding paragraph of Capt. Jones' report :—"When I heard of the Bussaco business, I began to be alarmed for the consequences of having done so much ; for if the lines had not come into play the expense would most likely have been cavilled at as unnecessary ; but now, of course, only the benefit derived from the strength of the works will be considered. I flatter myself you will be much pleased with the quantity of work of every nature done since your departure."

As the ground was strange to the several Divisions—the very existence of the Lines being unknown to the officers commanding—Lord Wellington, with his wonted foresight, had given instructions for the Engineer officers who had been engaged on the works to be told off as guides. Thus Col. Fletcher writes from Alcobaca, Oct. 5, to Capt. Jones ;—"Lord Wellington has directed me to write to you on the subject of guides for the different districts of our works," and after naming the officers for the duties and desiring that they might be at the Head Qrs. of the several districts, he adds that,—"Lord Wellington wishes that an officer of the ordenanzas, or any other respectable person well qualified from local knowledge, should be appointed, with about four men under him, also well qualified, to show the roads from the works along the positions, and those leading to them from the front. . . . The officers and a part of the men must be mounted. . . . I am sure you will make every arrangement for this service immediately. . . . I would recommend that the men should be constantly practised in acquiring every information about the roads of and bordering on the several districts. Every possible preparation is now of course necessary towards the defence of our works."

On the 8th Oct. amidst torrential rain—fit accompaniment of the pitiful scenes enacted along the lines of retreat, and which continued for several days, without intermission—the allied troops entered the positions prepared for them ; the several Divisions being shepherded by the guides into their respective stations ; nevertheless a good deal of confusion ensued in some parts, from unavoidable causes.

At this critical juncture, Lord Wellington's plans were suddenly altered to meet the exigencies of the situation. The army entered the Lines, with the expectation of taking up ground on the main, or second defensive position, in order to dispute—according to Sir John Jones, than whom no officer in the army was better informed of the Chief's intentions—the principal passes of Mafra, Montachique,

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Bucellas, etc.* But the movements of the troops not being pressed by the enemy—and the soldiers of both nationalities being animated with an excellent spirit, in consequence of the victory at Bussaco—an embarrassment was felt about the positions entrenched at Torres Vedras and Monte Agraca, etc., along the first line. To have abandoned those formidable works without a shot being fired would have produced the worst possible effects, not on the populace alone, but upon the troops. Consequently, Lord Wellington, aware of the great strength these advanced positions had attained, decided to halt at Sobral, and there abide the attack.

Reverting to the Diary :—

San Quintana, Oct. 11. This morning we were turned out of our poor Qrs. : regained it again. Dined at Lord Wellington's.

NOTE.—It was from here, on this very day, that Lord Wellington wrote to General Craufurd :—"Sta. Quintina, near Sobral, half-past 11 a.m. I hope that your men are well put up in Arruda in this terrible weather . . ." And next day he writes to Mr. Stuart :—"No tents arrived yet ; the troops are suffering everywhere for want of them." And to General Pack :—"In respect to tents, the Portuguese Government were to supply them, but they have failed in this, as they have in everything else."

Arranhol, Oct. 12. Head Qrs. moved here from St. Quintana. Sent from the fort of Sobral to mine a road below Zibreira, which occupied all night ;—the party from the Guards. *Oct.* 13. Met Lord Wellington on my way back this morning, after being relieved ; ordered back to see the mine exploded, and to get powder from the German Artillery.

Oct. 15. Head Qrs. moved to Enxara dos Cavaleiros. Our Qrs. robbed in the evening ; Chapman lost a portfolio with sketches, Col. Fletcher his dressing articles. Rode up to the Fort of Monte Agraça by daylight every morning, when both armies are under arms on their respective positions.

Oct. 17. *Pero Negro.* Arrived in this wretched village where it is said Head Qrs. are to be established. No good Qrs. except Lord Wellington's and the Adjt.-Genl.'s. Lived very well by sending to Lisbon for supplies, but much harassed by turning out before daylight every morning.

* The author of *Wellington's Lieutenants* could scarcely have been aware of this when he cast a slur on the professional reputation of a distinguished Engineer Officer, by stating that the Pass of Matos, "apparently had been unaccountably overlooked by Fletcher, who had superintended the fortifications" (page 152, General Craufurd). Had he consulted Sir John Jones' work on the Lines of Torres Vedras, he would have learned that the troops were employed continuously in completing and strengthening the position, which, at the last moment, Wellington had decided on holding.

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NOTE.—From the date above-named, until Nov. 5th, when Jones was detached to Lisbon on other duties, there are no entries in the Diary. The blank may be fittingly filled in by a quotation from Sir John Jones' History :—"Every morning, two hours before daybreak, the troops stood to their arms at the point of assembly of their several cantonments, as did also the garrisons of the several works; Lord Wellington, in person, being in the fort of Monte Agraça, in readiness to direct any general movement. The weather was generally wet, and the duty irksome; still, all supported it with cheerfulness, in the full confidence of annihilating their opponent, whenever the threatened attack should take place; but after a week had elapsed, expectation could no longer support itself, and the hope of an immediate and brilliant triumph subsided."

Lord Wellington, in a letter to the Earl of Liverpool, dated Oct. 27, 1810, wrote—"I am not quite certain that I ought not to attack the French . . . but I think the sure game, and that in which I am likely to lose the fewest men, the most consistent with my instructions and the intentions of the King's Government; and I therefore prefer to await the attack."

The condition of the French *vis-à-vis* of the Lines was deplorable. Massena had followed leisurely in the wake of the allied army, without stores, and short of provisions, buoyed up with the prospects of enjoying the plunder of Lisbon, which wealthy city he reckoned as already within the grasp of his troops. When, therefore, he found his path blocked by the impregnable Lines of Torres Vedras—of whose very existence he had been unaware—he must have experienced a rude shock. As time went on, the situation of his troops becoming desperate, retreat was inevitable.

From this check in front of the Lines may be dated the decline of French power. As Sir J. Jones truly observes :—"It was the first and only instance of a military enterprise planned and matured by Napoleon, whilst in the plenitude of his power, being defeated by the steady perseverance and superior foresight of an opponent."

To return to the Diary :—

Nov. 5. Set out from Pero Negro this morning, being ordered to assist Capt. Goldfinch in reconnoitring the left bank of the Tagus opposite Lisbon and the Peninsula between Aldea Gallega and Setubal.

NOTE.—This expedition was connected with certain defensive works, rendered necessary by a report from the Admiral commanding in the Tagus to the effect that, owing to the increasing number of ships in the river, they would be liable to destruction from the fire of the enemy, in the event of his seizing the heights on the south side. Lord Wellington, in his reply to Admiral the Hon. G. Berkeley, wrote :—"It is quite clear to me that Portugal and England cannot afford a force to do more than defend one side of the river; and if

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the transports cannot remain in safety, the enemy being in possession of the left bank, the defence of the country ought not to be attempted. . . . I am perfectly aware of the strength of the ground on the left of the Tagus . . . and I have reports and plans for fortifying and occupying it, but I have never thought of carrying the plans into execution for the reasons I have above stated."

As matter of fact, certain defensive works, together with roads of communication, were subsequently constructed along the heights on the south bank, as shown on the plans attached to Sir John Jones' account of the Lines.

Messrs. Goldfinch and Jones having reconnoitred the ground, returned to Lisbon on Nov. 10th. *Lisbon, Nov.* 15. The French retired to Santarem last night. (During the next 3 weeks Jones remained in Lisbon; Col. Fletcher and various officers being engaged, from time to time, in superintending work on the south bank of the Tagus).

It may be of interest here to mention a circumstance which seems to have escaped the notice of historians namely, that Lord Cochrane, who was on board his yacht, the *Julie*—originally a small French warship which had been captured, and afterwards bought by this officer—in the Tagus, when the troops entered the Lines (Oct., 1810) with his accustomed zeal,—although on half-pay at the time, volunteered to go up the river and destroy all the French boats at Santarem.

From Capt. J. Burgoyne, Royal Engineers.

Cartaxo, 20*th Nov.*, 1810.

My Dear Jones,

I cannot do less than write you the news in return for the letters I received from you on your first joining the army. Head Qrs. have been here for these three days past; it was understood that the greater part of the French Army had crossed the Zezere, and that only 5 Regiments were left in Santarem; under that impression an attack was intended yesterday. The French force is posted in rear of the Causeway about two miles from Santarem; and they have their artillery posted to fire along that approach. It was therefore arranged that General Pack should turn their right, and the light brigade their left. General Pack's Division arrived in good time at the ford or causeway by which it was intended he should cross the valley; but the Artillery and Dragoons intended for his support mistook the road; the latter did not arrive until very late, and the former did not reach him during the day. General Pack having observed two Battalions posted with four Cannon on the opposite side to oppose his passage, deemed it proper to send to Lord W. to know if he should attempt it without his guns. All this created delay, and at 3 o'clock it was judged too late to attempt anything that day. It is said that in the evening His Lordship received information that the bulk of the French Army is on this side the Zezere, and in consequence determined to substitute a false attack for the real one, and to see if the enemy could be

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frightened enough by it to give up the hill defending the causeway, and retire into Santarem. All the usual demonstrations were made this morning; the different columns were put into motion, and the light troops skirmished absolutely into the rear of the post; but devil a bit did a Frenchman move from his ground. It is therefore concluded that the enemy is in force at Santarem, and as we do not deem ourselves strong enough to carry a small advanced post, an attack upon Santarem itself cannot be for a moment expected. I therefore think we shall remain here until Massena is reinforced, when we shall again return to Pero Negro. I have made up my mind to a daily wetting. I will thank you to send the accompanying letter for Ross to the Portuguese Post Office. Saturday is Mafra post day.

Believe me, yours very faithfully,

J.B.

I am nearly out of Horse Shoe Nails; if you will send me up a few I shall be very thankful to you. Your horse is come quite round, and I expect will be in very fair riding order in ten days or a fortnight.

Dec. 16. After inspecting the Bridge of Mealhada, (Ponte de Rio Georgo) with Col. Fletcher, consisting of 3 small arches over the Rio Mayor, began a mine, with a party of the Guards. *Dec.* 25. Completed the Mine and loaded it with a Barrel and a half of powder. Returned to dinner (Xmas Day) and just sitting down to it with the Brigade Major, when the Col. came from Lord Wellington's where he was to dine, to desire the bridge in the Causeway leading to Santarem to be mined immediately. Sent the mules with some intrenching tools, eat my dinner and set out for the Bridge. Waited from half-past 8 till 10 o'clock for a party, during which time I rode to Genl. Craufurd's Qrs. who was dining out. Procured a few men from the inlying picket commanded by Capt. Jones of the 52nd Regt. Began about midnight; although close to the abattis that separated our sentries from the French, and the noise reverberated on the arch, the enemy gave us little interruption. Brig.-Major Jones relieved me at 4 o'clock, and completed the mine soon after light.

Cartaxo. Dec. 26. Sent to the left of our position on the Rio Major, and mined a small bridge of one arch; could obtain only 9 in. in depth. Loaded it with 60 Six-pounder Cartridges. Lost my way in the darkness and intricate by-roads, with a dragoon that accompanied me, till daylight.

Dec. 30. At Major Sturgeon's suggestion an attempt was made to dam the Rio Major, by filling the arches of Ponte St. Anna with wine casks.

THE WINTER OF 1810–11.

Behind the Lines.—The influx of such a host of destitute and starving creatures—almost the entire population of a province and the principal inhabitants of Coimbra and other towns,—raised the gravest

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apprehensions in Lisbon. The number of refugees that had to be cared for during the winter of 1810—1811, was estimated at three hundred thousand, irrespective of about one hundred and twenty thousand troops. And the task of providing food and shelter for this immense multitude was a gigantic one. Yet it was accomplished. All classes united in the endeavour to mitigate the sufferings of the poor creatures to the utmost of their power;—"everything which prudence and humanity could suggest," wrote an eye-witness, "was done by the inhabitants of Lisbon to alleviate the public misfortune. Charitable institutions were set on foot, and food was daily distributed to such of the fugitives as were necessitous and helpless, while labour was provided for the others." Nor was the British nation backward in showing sympathy for its "ancient ally." The officers of Lord Wellington's army contributed liberally out of their private means; while at home, the House of Commons voted for the relief of the poor sufferers a sum of one hundred thousand pounds; a sum at least equal to this being raised by voluntary subscription; and the money was very judiciously employed in the purchase and freightage of such things in Great Britain as the Portuguese were most immediately in want of.

"The misery and wretchedness of the refugees is beyond description," wrote Capt. Dickson (Sir A. Dickson) of the Portuguese Artillery, (Feb. 28, 1811); "numbers are perishing from disease and want. A very handsome subscription was made by the British Division for the poor at Chamesca, but, alas, it is all gone, and the streets (in Chemesca) are as full of misery as ever. It is quite melancholy to see the state of the poor people; women are to be seen in all directions gathering herbs which they cook and nearly live on."

Later on, after the expulsion of the invaders, a large additional sum of money was sent from England, with a view to resettling the peasantry on their derelict farms; and a joint commission, partly British and partly Portuguese, was engaged for several months in examining claims and apportioning the awards.

And so Lisbon was saved, and with it the cause of European freedom. But at what frightful cost the world will never know. Great Britain still bears the burden of that tremendous contest in her National Debt.

And how did the inhabitants of the Portuguese metropolis bear themselves under the strain of that terrible winter? After the first few weeks a reaction set in; the people as it were, became intoxicated with a strong feeling of security:—"There never was a period," wrote an eye-witness, "when this city was crowded with more objects of misery; yet at no time had their theatres been better filled, their societies more gay and brilliant, than when seventy thousand vindictive enemies lay within sixteen miles of the city, panting for the plunder of it."

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The following statement might seem incredible were it not made on the authority of General Cockburn, who wrote :—" Last winter, when there was great distress in Lisbon, and men were absolutely starving, public offers were made of rations and 6d. a day to any man who would work on the Lines ; yet the majority preferred an existence on casual charity, and basking in the sun, to the above wages and work. The French," he adds, "took a much shorter and better plan ; they gave no money and forced them to work."

Before the Lines.—The condition of the French Army, during this terrible winter, was unspeakably wretched ; but no amount of suffering could palliate their savage treatment of the innocent inhabitants of a country they had, avowedly, entered to protect.

Perhaps the most realistic and terrible description of the barbarities practiced by Massena's troops during this awful period, is that touched on by Southey, in his History of the War. With a profounder knowledge of Portuguese history than any foreigner, and excellent source of information at command, he takes us behind the scenes, and affords us glimpses of what was taking place in the rear of the French position. One or two extracts from this little-studied work will enable the reader to realize in some faint degree the sufferings of the unfortunate Portuguese during this most terrible crisis. Describing the French marauding parties, Southey tells us that "they were soon left to take their course, without the slightest attempt at restraint. . . . In excuse for this, the French officers observe, and truly, that the army must otherwise have perished.

"The skill which some of these marauders acquired in their search for food, resembled the sagacity with which savages track their prey. That they should detect with unerring certainty any place of concealment in a dwelling or an out-house, might have been expected ; but when they were questing in woods, or among rocks, or in the open country, a new sense seemed to be developed in them. There were men in every company who could discover a depôt of provisions by scent far off.

The conditions under which Massena's troops found themselves, during that terrible winter, were doubtless responsible, to a great extent, for their conduct."

Very apposite are the reflections of an officer on the staff of Marshal Beresford :—"How little does the independent, happy English peasant know how to value the peace and security in which he lives!"—wrote Capt. Warre to his father, during the retreat,—"And how would those miscreants who preach discontent and faction through the country, giving them ideas of wants and liberties which are incompatible with society and government—how would they blush if they were to witness the sufferings and oppression which these poor people undergo."

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The following order from Lord Wellington was intended to check the writing of alarmist letters by officers and men of the British Army :—

CELORICO, *Aug.* 10, 1810.

The Commander of the Forces publishes to the army the extract of a letter, conveying enclosures from the Vice Consul at Oporto, and of British officers of rank in the army, exciting alarm in that city.

The Commander of the Forces will not make any enquiry to discover the writer of the letters which have occasioned this unnecessary alarm, in a quarter in which it was most desirable it should not be created. He has frequently lamented the ignorance which has appeared in the opinions communicated in letters written from the army, and the indiscretion with which those letters are published. It is impossible that many officers of the army can have a knowledge of facts to enable them to form opinions of the probable events of the campaign; but their opinions, however erroneous, must have mischievous effects.

The communication of that of which all officers have a knowledge, viz. the number and disposition of the different divisions of the army, and of its magazines, is still more mischievous than the communication of opinions; as must be obvious to those who reflect that the army has been for months in the same position: and it is a fact, come to the knowledge of the Commander of the Forces, that the plans of the enemy have been founded on information of this description, extracted from English newspapers; which information must have been obtained through private letters from the officers of the army.

Although the difficulties, inseparable from the situation of every army engaged in operations in the field, particularly in those of a defensive nature, are much aggravated by communications of this description, the Commander of the Forces only requests that the officers will, for the sake of their own reputations, avoid to give opinions upon which they cannot have a knowledge to enable them to form any: and that if they chose to communicate facts to their correspondents, regarding the positions of the army, its numbers, formations of its magazines, preparations for breaking bridges, etc., they will urge their correspondents not to publish their letters in the newspapers, until it shall be certain that the publication of the intelligence will not be injurious to the army or to the public service.

1811. Early in January, Jones obtained a short leave to visit Lisbon on business, and put up at the "Lion d'Or." For a description of the principal Lisbon Hotel, we must turn to the narrative of another officer, who is more explicit on the subject, than our Diarist. "Not an inn," he writes, "is to be found in which you could pass the night without undergoing the tortures of hell, almost as bad to me as flames and brimstone. I made an attempt to lodge in one (Lion d'Or); but had I been destined to pass my nocturnal hours in the most wretched hovel in England, or to have put up in this place, I should have preferred the former. It would be impossible to find in all Great Britain a habitation so ruinous, so ill-furnished, so filthy, and so infested with vermin as this; and yet this was the Lion d'Or, the chief hotel in the city."

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CARTAXO, *Jan.* 8, 1811.

MY DEAR FATHER,

. . . Our Head Qrs. continue in this town and the outposts are situated as I described in my last; and the peace which then appeared to reign between the two hostiles remains uninterrupted. I fancy the French have received the expected reinforcements under General Devoust, but I do not believe they will attempt anything until they get still larger reinforcements.

My friend Capt. Chapman left us about a fortnight ago; I spoke to him previous to his departure respecting the Adjutancy, and I am sure he will do everything in his power for me; but I fear he will arrive too late to profit by Lord Mulgrave's friendship. . . . You know best whether Sir W. is at all disposed to forward my views in life; if he is, I need hardly remind you that the only way an officer of our Corps can get on at all, is by getting something out of the immediate Regimental duty, if possible still under the Ordnance. . . .

You will see by the impression that I have been obliged to get a new seal; my old one was stolen, with (what I regret infinitely more) the watch Sir Watkin was good enough to give me, from the table in my Quarters, which, from the depredations of the French, is without locks and almost without doors.

Your very dutiful and loving son,

RICE JONES.

Later on in January, he paid a visit to his friend Goldfinch, at Almada, on the south side of the Tagus, putting up at his Quinta, and the following day "rode with him along the works he is constructing, and then got him to return to Lisbon with me; met Burgoyne, Ross, etc., and dined together."

Jan. 20. Received an order to take charge of part of the works at Almada whilst waiting for the arrival of the Artificers, (from England); crossed with my horses to Cosilhos (Casilhas or Almada), and from thence went to Nossa Senhora Da Monte, as arranged with Goldfinch, on the right of his line of works; got a good Qrs. and agreed to live with Thomson during my stay.

Jan. 23. From Monday morning (21) to this, employed in getting acquainted with the duty at Almada. In the middle of the day Goldfinch gave me a letter ordering my return to Head Qrs. Crossed over to Lisbon immediately. Heard of the death of the Marquis de la Romana at Cartaxo last night; also of the appearance of a party of French under Junot at Rio Major, on the 19th inst. Junot received a severe wound and they retired during the night.

On Jan. 25th, Jones rejoined Head Qrs.; next day—"rode with Capt. Jones to Alcoentre, and received from him directions for carrying on the works to be erected here. Maj.-Genl. Colville, who commanded here, made me an offer of his house and table during my stay.

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Jan. 27. The party finished felling the fir wood. Laid out the embrasures in the Battery above the town.

Jan. 28. Commenced a Fascine manufactory; weather very fine but hot.

Jan. 29. Received at night an order to form 2 abattis, cut Olive-trees, and form a dam.

Feb. 6. Rejoined Head Qrs. Hear that the French broke ground before Badajoz on the 3rd inst.

Cartaxo, Feb. 7. Feeling unwell applied to Dr. Gunning for medicine and advice. Everything continuing quiet; mornings regularly occupied waiting for orders at the Adjt.-Genl.'s; the remainder of the time disposed of by Col. Fletcher, with whom and the Brig.-Major I mess and live very comfortably.

CARTAXO, *Feb.* 9, 1811.

MY DEAR FATHER,

. . . . . .

Nothing of consequence has occurred between the hostile armies since my last. The French entered Rio Major on the 20th Ult., but withdrew from thence the same night, and Junot was severely wounded whilst reconnoitring near that place by one of our videttes. The Marquis de la Romana died in this town a day or two after. I am very glad to tell you that the Spanish Army of 8 or 10,000 men, . . . have returned towards the Spanish frontier, near Badajoz, which Fortress has been completely invested by Mortier's Corps, who broke ground before it on the 3rd Inst.

I have been attached to the left Division (M.-Genl. Picton's) ever since the appearance of the enemy in that direction on the 20th Inst. and have been throwing up a few batteries, cutting down trees, forming abattis, etc.; I was attached to the Honble. M.-Genl. Colville during the time; he was very civil, and I lived at his table constantly; I returned from thence yesterday. The appointment of Brigade Major makes little or no difference to me, as Adjutant; he is, I believe, much my friend, and in every way a sterling character, both as a man and an officer. . . . If I get it (the home appointment), I shall now have the satisfaction of knowing that I do not owe it to any application, or importunity of my own; and if I do not, I shall only have to remain contented, and without feeling particular obligation to any of my friends in office. . . . I fancy the augmentation will be out, and everything arranged before you receive this.

I remain, my dear Father,

Your very affectionate son,

RICE JONES.

March 6. Heard the French had begun to retreat from Santarem last night.

NOTE.—The retreat of the French from Portugal was the inevitable sequel to the events of the past five months. Massena, early in Oct.,

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1810, finding his progress blocked by the Lines of Torres Vedras, after fretting in front of them for a month, not daring to assault, and too proud to confess failure, by retreat, placed his troops in winter quarters about Santarem. Thus situated, his army greatly deteriorated—the fruit of indiscipline, want of provisions and supplies of all sorts, to say nothing of despondency, the natural outcome of baffled hopes. Had Wellington possessed the highly-tempered weapon which was subsequently forged, he would assuredly have fallen, tooth and nail, on to the enemy, and driven them a disorganized rabble, across the frontier. But with his hetereogeneous army of four different nationalities, it would have been folly to risk the momentous interests at stake on the issue of a general action. He had no alternative, therefore, but to bide his time. Meanwhile "General Starvation" was working ruin amongst the enemy, whose long-delayed retreat was marked by the most ruthless devastation. Suffice to state that the track of the retreating army was a desert for long after, littered with smoking ruins, amidst which lay the charred corpses of their late occupants—the peasantry of Portugal.*

Massena re-crossed the frontier on the 5th of April. He had entered Portugal, nine months previously, with nearly 70,000 men—veterans who had beaten the best soldiers of the Continent, and who anticipated an easy conquest of Portugal, together with the expulsion of the "English leopard." He repassed the frontier with 45,000—which included 10,000 reinforcements. The campaign had, therefore, cost the French 30,000 men—to say nothing of the enormous loss of reputation resulting from such a calamitous failure. No French army ever again entered Portugal.

The following extract from a Diary is in the handwriting of Rice Jones, and describes Massena's retreat from Portugal.

HEAD QRS., LOUCAO, *Saturday*, 16 *March*.
About 1½ Leagues in front of Miranda do Corvo.

Monday, 11*th*. The enemy being still posted in front of Pombal all the troops were brought to that point; by noon they were driven out of the town, having first set it on fire. They then retired to a position in rear of the town and appeared to be from 20 to 25,000 in number; every preparation was made to attack them, but it became so very late before the rear Divisions could be brought up, and most of the men having marched six leagues, the attack was deferred until the morning.

Tuesday, 12*th*. The enemy retired in the night and we did not overtake them till within ¾ of a league of Redinha. They were posted on a height

* "When they looked on these scenes of desolation," wrote an eye-witness, "and considered the desecration of everything, whether sacred or profane, their hearts grew sick within them, and they thought of the happy isle which they had left behind, where such horrors are unknown—unknown to the mercantile citizens, who grudge so much the pittance received by the poor soldier."

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at the extremity of a heath, having a view of their front of two miles. The country we were marching through was very close and intersected; on their right was a woody hill. Our Light Division were ordered to drive them out of it, whilst our columns were coming up, and which they did in great style. Our columns then deployed into two lines and a Reserve, (35,000 men) and advanced across the heath (being under a considerable cannonade), our guns as usual in front. It was a beautiful sight, every man could be seen at the same time. The enemy could not resist, and were driven down the hills, through Redinha, the guns cutting them up famously. Redinha they burned.

Wednesday, 13th. The enemy had marched all night, and we saw nothing of them till we came within two miles of Condeixa, where we found their army. Whilst our troops were bringing up, they marched off by the road to Miranda do Corvo, having first burned Condeixa.

Thursday, 14th. This was a day of incessant fighting; our advanced guard had not moved half a mile when the skirmishing began, and it continued for 2 leagues, until we came upon the entire of their army; as usual, whilst our troops were coming up they moved off.

Friday, 15th. A thick fog till 10 o'clock gave the enemy 4 hours start of us, and it was the evening before we came up with them; they were then discovered posted about the Alva. By a very brisk and skilful attack they were driven from some ground they held on this side the Alva, but it became dark before it could be ascertained whether they were all driven across the river.

Saturday Morning, 16th. The enemy is now posted close to the Alva, and I think it probable His Lordship will attack them there. Massena has ordered every town and village to be burned as they quit it, and too faithfully is the order obeyed—scarcely a house escapes. We take very few prisoners, their retreat being conducted in the most skilful manner; and was not Massena such a horrid monster of cruelty, I would praise his military skill. His Lordship, on his part, has shown himself an able General.

P.S.—Since I closed this, I have been to the advanced posts and find that the enemy is filing off without any apparent intention of making a stand at the Murcella position. They have their rear-guard strongly posted above the bridge which they have destroyed over the Alva. We have therefore come to a halt for the day, as we cannot repair the bridge whilst their rear-guard remains.

On March 29th, 1811, Jones set out from Lisbon to rejoin the army. "ALCOBACA, *April 3rd*—reached this place, once so exceedingly beautiful; lodged ourselves in the remains of an elegant house appertaining to the factory, which, with the whole town, and the venerable Convent is reduced to ashes by a party of French sent for the express purpose, and who left in the stables, that are alone undestroyed, green fodder that sufficed for our horses.

April 4. Before we left Alcobaca this morning, Ross and myself visited the Chapel, etc., found one solitary monk repairing the Royal

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Tombs that had all been opened and broken. The body of Inez de Castro being exposed. The Library and Archives are preserved in an extraordinary manner, fire having evidently been lighted to consume them, etc. Sick and disgusted at scenes so depraved, and degrading to human nature, we went to Batalha,* which, being nearer the Great Road taken by the enemy has suffered considerably more than Alcobaca. Not a room in the Convent is left standing. The embalmed body of King John ('The Great'—the Founder of the Abbey, who, with his English wife, Philippa of Lancaster, had reposed here undisturbed, in a superb Mausoleum, for the space of four centuries) lay on the pavement in the middle of the Church; the bones scattered and mixed with others, designedly; and the Tombs rifled and defaced in the most wanton manner. Here, and at Alcobaca, all the organs were burnt to cinders."

To this brief account of malicious vandalism might be appended the narratives of other British officers—many of whom—like the author of the Diary, had often, on previous occasions, partaken of the generous and kindly hospitality of the monks of these two magnificent Convents.

Passing on, they—"found Leyria destroyed so much that we could with difficulty procure a quarter for the night." And thence to Condeixa—"formerly so famed for the beauty of its situation, etc.; with surprise and grief, found it burnt to the ground; not even a single house remaining; except those detached at a little distance in the valley below, where we took possession of a large house uninhabited."

All this was familiar ground, having been occupied by the British Army less than a year previously. The two officers now branched off the line of retreat, reaching Villa Pouca, April 7th—"where we were hospitably entertained by the principal proprietor, a well-informed old man who retained the country manners most completely." Thence onwards, they—"saw with regret the ruins of the large house at Cea, as well as many others we remembered." April 12th, they rejoined Head Qrs., meeting there Col. Fletcher and several other brother-officers.

VILLA FORMOSA, *April* 14, 1811.

MY DEAR FATHER,

. . . I was obliged to remain at Lisbon to receive and distribute the Detacht. of Officers and men from England, there being no officer of our Corps in that city, and have consequently missed all the affairs our army have been engaged in during Massena's retreat. The Newspapers will

* For a detailed description of this noble building, the reader is referred to the sumptuous work of James Murphy:—*Plans, Elevations, and Views of the Royal Monastery of Batalha* (published in 1793). For the completion of this work, the author, who was an architect, resided for three months in the Monastery.

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give you much better accounts of them than I can; they have invariably been successful and brilliant; but it is a question whether we have made the most of the opportunities so often afforded us of completing their rout and disorder. They are now however clear off to Ciudad Rodrigo and Salamanca, having left a garrison in Almeida, which fortress is completely surrounded by our troops; but I believe we are not to commence any active operations against them, but content ourselves with merely blockading the place.

I was not able to settle everything and quit Lisbon until the 30th; from that day to the 12th of the month I have been endeavouring to rejoin Head Qrs., and at length, after a march of nearly 300 miles through the country exhausted by the hostile armies, the towns and villages burnt, and the roads hardly passable, I have once more found them at this little village, about half a mile from the Spanish frontier, and 1½ or 2 leagues South of Almeida. I never experienced so many difficulties to impede one's progress as in this march; only once or twice was I able to get any corn for my horses—never either hay or straw, and seldom any grass. My large horse was so very ill (in fact quite done up) that I was obliged to leave him behind me at Lisbon; and my baggage pony being perfectly unable to get over the vile roads, with little or no food, I was obliged to exchange him on the road for a stronger baggage animal, giving an exorbitant price with him. It rained every day but the two last; and notwithstanding all my purchases on the way, I had some trouble to get up with the army. To complete the business I am now ordered to join the troops in the Alemtejo, under Marshal Beresford, at Elvas or its vicinity, Lord Wellington having it in contemplation to besiege Badajoz has ordered all our officers that can be spared from other services, together with every requisite store for a siege, to be sent immediately to Elvas. Ross and 11 or 12 other officers are on their way there, and I shall set off the moment my stud is able to proceed. We do not as yet know whether Col. Fletcher will be allowed to go there himself, or indeed whether Lord Wellington may not take a trip in that direction; should they not, Capt. Squire will be the senior, and have charge of the siege. For my own part I am not quite clear that it will ever be undertaken, and indeed I shall not be surprised if when we arrive at Elvas, and everything is ready, that we were all to be ordered back again. It is as yet a secret in the army.

Your very affectionate son,

RICE JONES.

"*April* 15. Set out for the Alemtejo this morning; Lord Wellington taking with him none of his baggage, and but few attendants. Passed thro. Frenada, etc., to this town (Sabugal) which is nearly in the same ruinous state the French left it in, when they were driven out above a month since."

Next day's march to Pedrogoa Grande was—"principally over mountains covered with odoriferous shrubs; the day very fine, and everything freshened by last night's rain;—through Penamacor,

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an ancient fortress upon the steep slopes of a mountain. This is a good-sized village, little the worse for the French." At Castello Branco, the next halting place "Lord Wellington occupied the Bishop's Palace." And so on, through Nisa, to Portalegre, where the Qrs. "were very good and provisions plentiful; the situation and scenery very fine," to Elvas, where Head Qrs. were established while Lord Wellington arranged with Marshal Beresford the course of future operations.

Matters had not been going well in the south of Portugal where Beresford was in command; hence, says Napier, "The presence of the general-in-chief was agreeable to the troops; they had seen great masses put in motion without any adequate results." Wellington's instructions to Beresford had been to throw a bridge over the Guadiana at Jerumenha, push back the French under Mortier, and invest Olivenca and Badajoz. Beresford, however,—"preferred halting for the means to cross at Jerumenha, and thus commenced in error those bloody operations which marred Wellington's great conceptions for carrying the war into Spain, and detained the army more than a year on the frontiers of Portugal."

Olivenca had surrendered on the 15th April—the day on which Wellington had set out for the Alemtejo; but the governor of Badajoz had been allowed to repair the works and bring in materials and stores, unchecked.

(To be continued).

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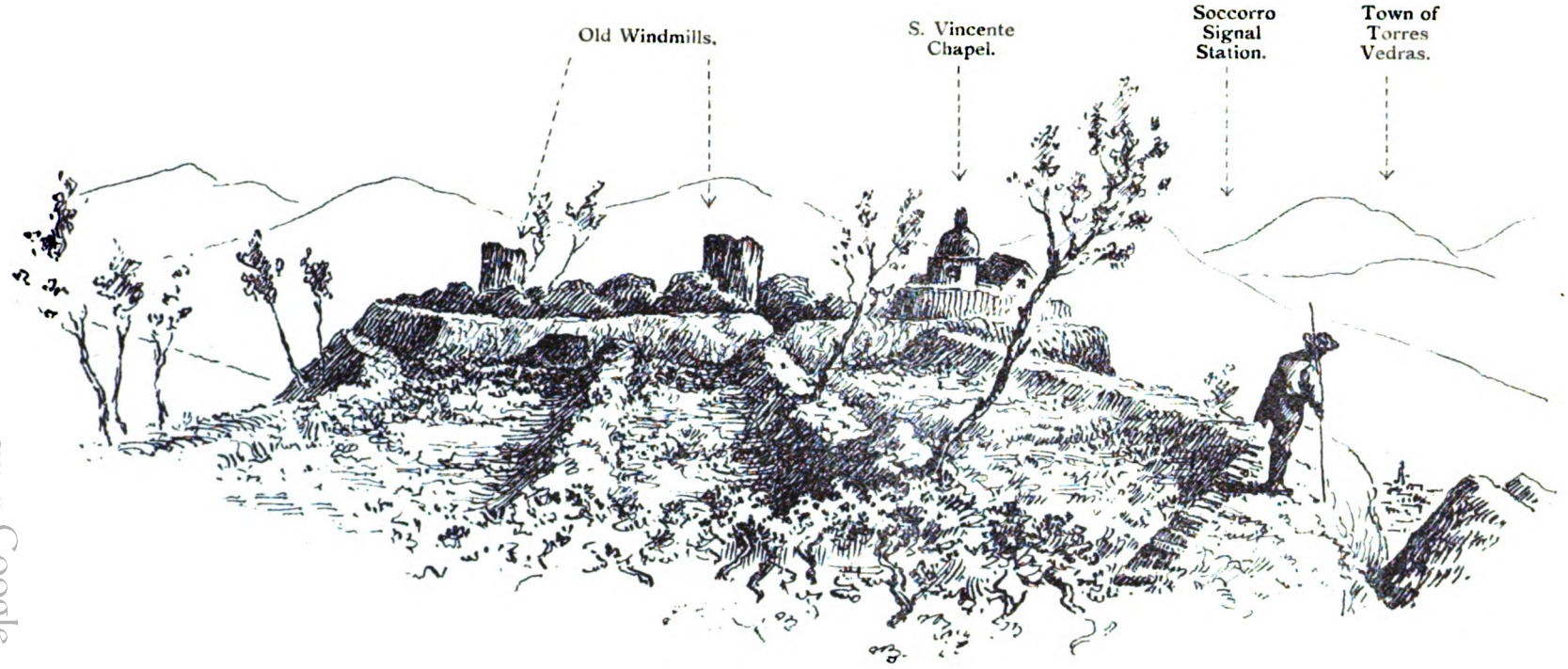
Interior of the Great Redoubt at Torres Vedras which mounted 33 guns and required a garrison of 1,720 men. Now a vineyard.



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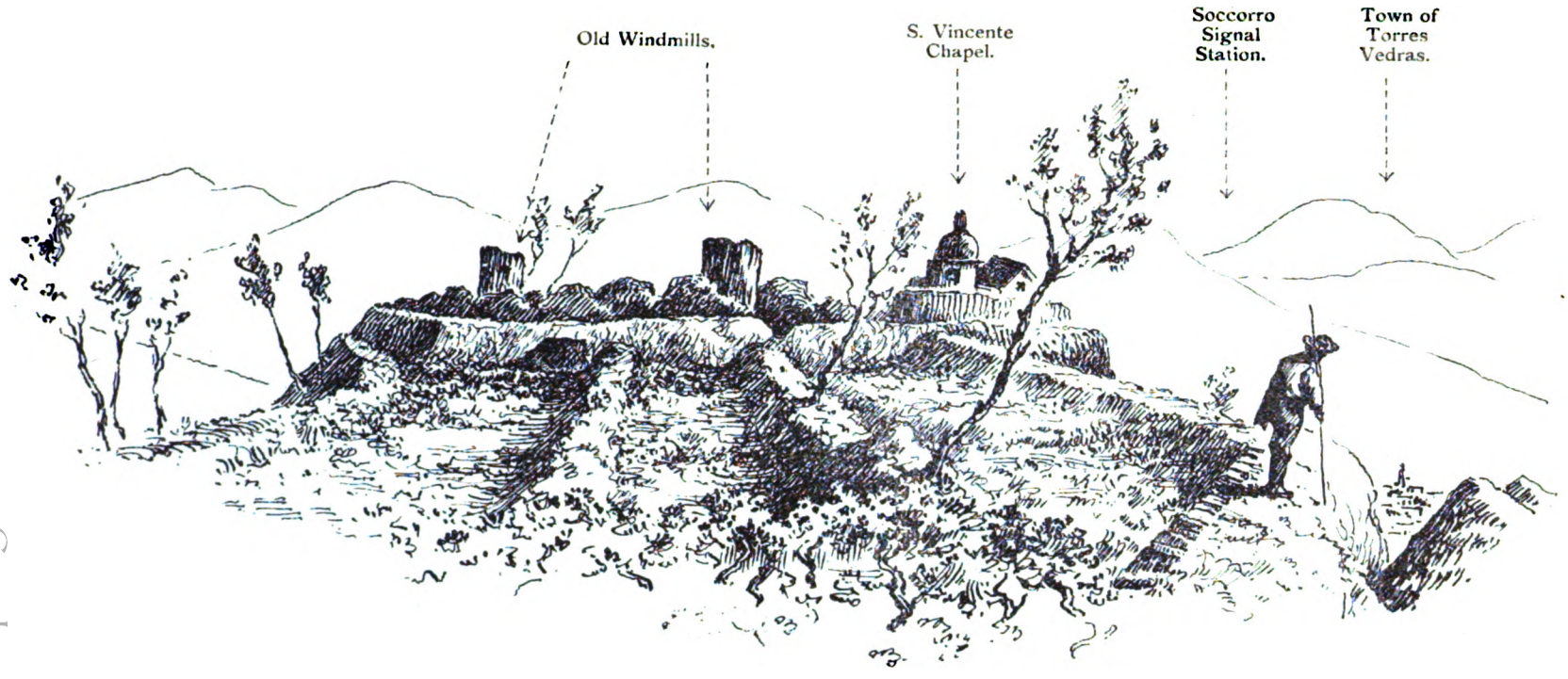

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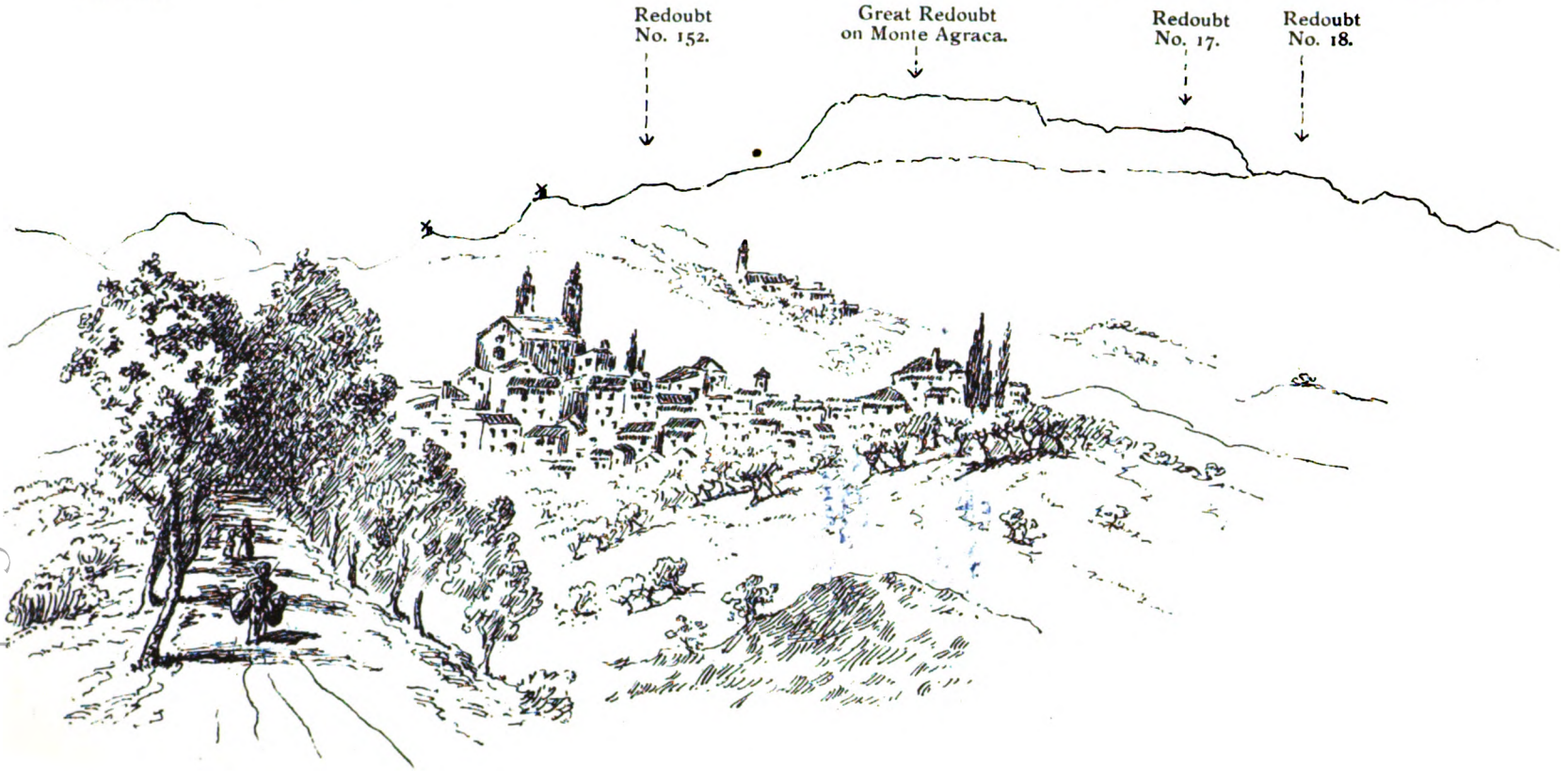
Sobral and the Monte Agraça from the Torres Vedras road. This was the only place where any fighting took place; the French seized the town.



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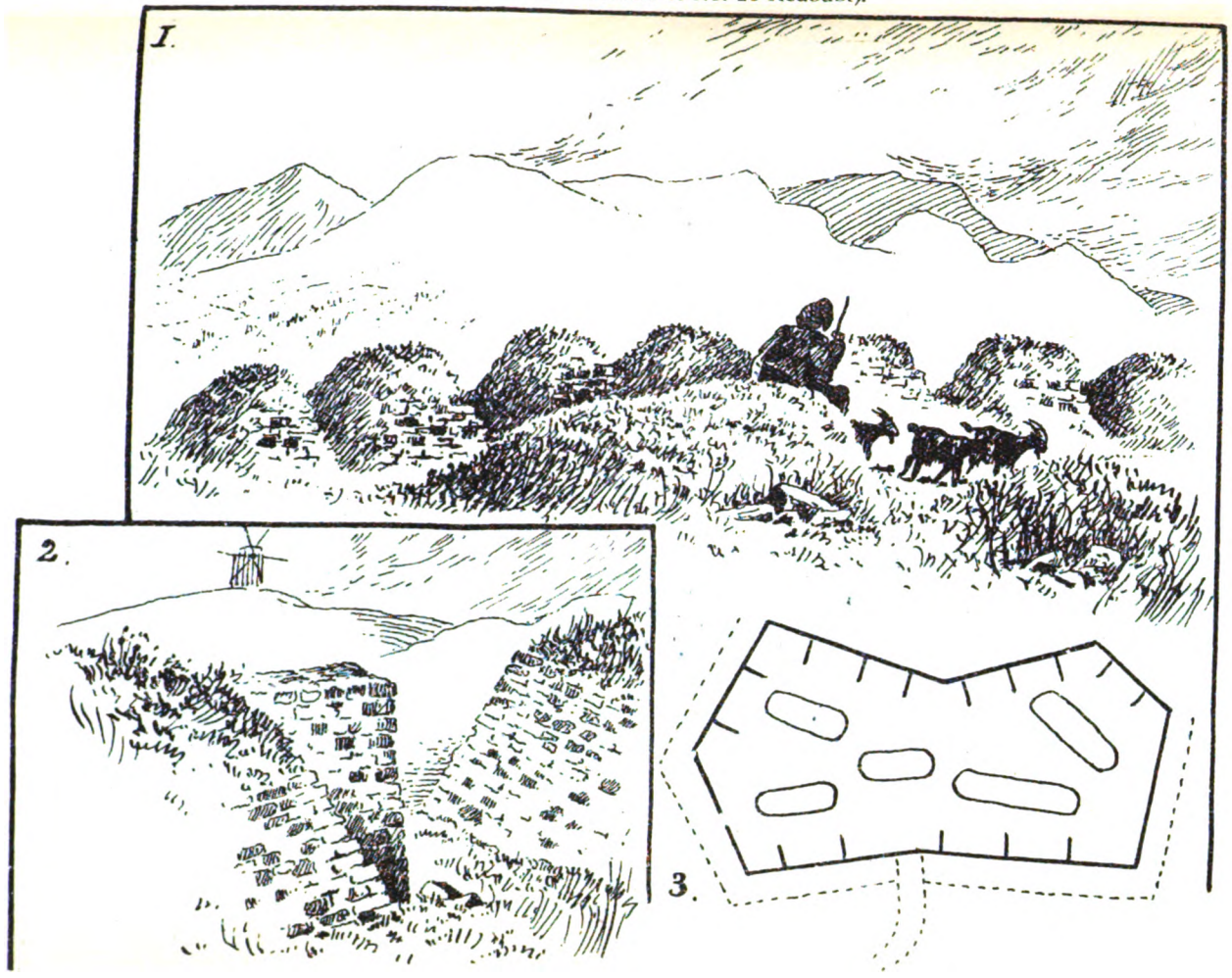
...149, near Torres Vedras. 2. The dry ditch and approach. 3. Ground plan.
(Note.—The windmill marks the site of No. 26 Redoubt).



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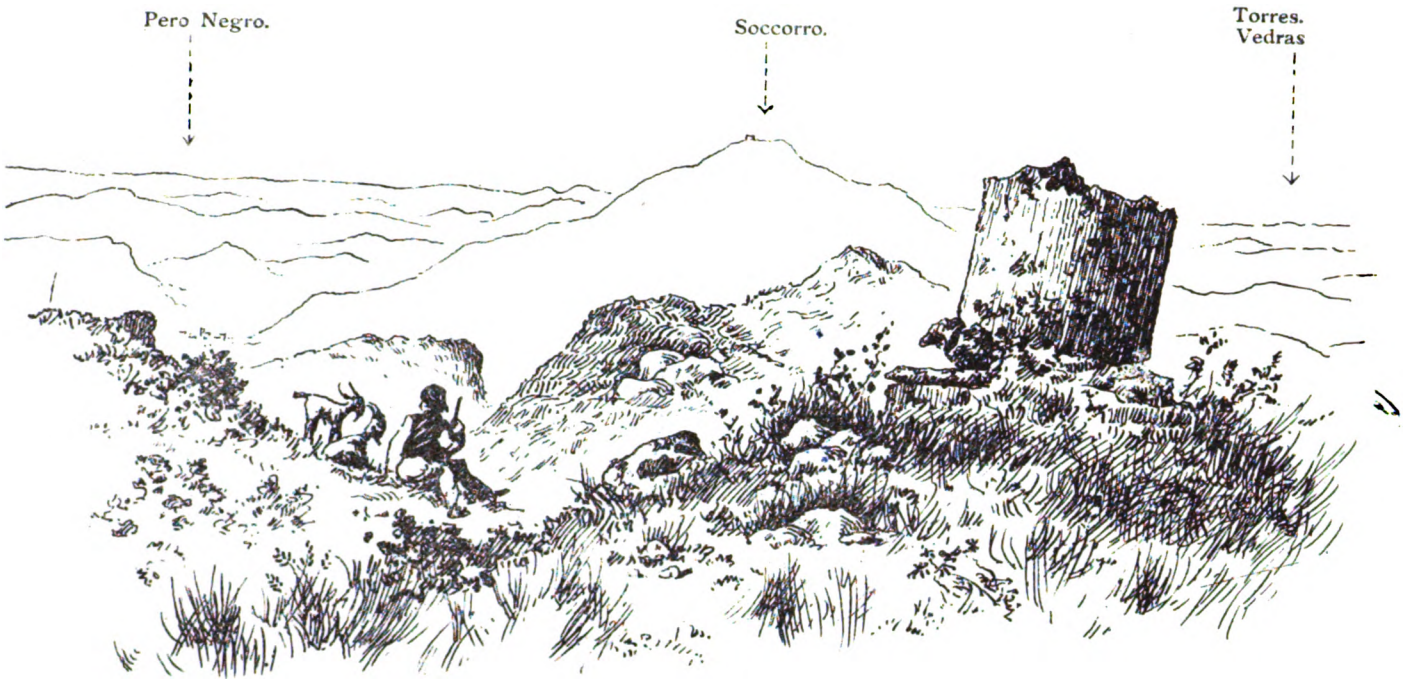
In the Great Redoubt on Monte Agraça, looking west. The stone pedestal is the base of the signal-pole (most probably). This redoubt was the central and loftiest point of the Lines; it required a garrison of 1,000 men, and was armed with 25 guns. The dependent works mounted 19 guns, and required 1,000 men for their defence.



"Every morning, two hours before daybreak," says Sir J. Jones, "the troops stood to their arms at the point of assembly, as did also the garrisons of the several works; Lord Wellington, in person, being in the fort of Monte Agraça, in readiness to direct any general movement. . . . The weather was generally wet, and the duty irksome; still, all supported it with cheerfulness, in the full confidence of annihilating their opponent."

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REVIEW.

A BRIEF HISTORY OF THE KING'S ROYAL RIFLE CORPS.

No regiments in the British Service take a greater pride in their past history and achievements than the two famous Rifle Regiments whose recruits are trained at Winchester. Regimental history is an important part of recruit training at the Rifle Depôt, and a short history both of the 60th and of the Rifle Brigade forms a prelude to the Standing Orders of both regiments.

A History of the King's Royal Rifles is now under preparation by Capt. Lewis Butler. It will be some time however before this history will be completed, and in the meantime the History Committee of the regiment under the chairmanship of Sir Edward Hutton, one of the Colonels Commandant, has brought out the small volume of 52 pages now under review. The object aimed at by the History Committee has been "to narrate in a concise and popular form the origin, history, and world-wide services of the several battalions, so that every Rifleman may be able to learn at least the outlines of the history of his regiment—a corps whose battle honours are unequalled in number, and whose reputation for discipline and courage is unsurpassed in the annals of the British Army."

The committee may be congratulated on having succeeded admirably. The story, although concise, is not wanting in life and colour, and the four maps illustrating campaigns in Europe, Asia, Africa, and America, are good examples of clear printing, and contain no irrelevant names. Altogether the book is a model of what a short regimental history should be.

A portrait of the King as Colonel-in-Chief of the regiment forms the frontispiece, and the volume is well got up in every way. The binding is of green cloth with a red edging and contains an excellent representation of the regimental badge in silver.

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NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

October, 1912.

OBJECT OF THE ORGANIZATION OF THE SWISS SCOUTS.—A summary of General Baden-Powell's Boy Scout scheme.

MILITARY AVIATION.—A description of some of the exhibits at the Aeronautical Exhibition in Berlin, 1912. This exhibition included only aeroplanes—the dirigible was excluded—and showed to what degree of perfection the Germans have arrived in aviation. The proportion of monoplanes to biplanes was 2 to 1. Two good photographs and descriptions of Albatros biplanes are given, also of monoplanes by Goedecker, by Rumpler, and by the Sociétés Automobil et Aviatik.

THE MANŒUVRES OF THE 3RD CORPS D'ARMÉE IN 1912.—The 5th and 6th Divisions have recently been reorganized, and brigade commanders and troops had not made each other's acquaintance. The organization of the artillery and engineers had also been modified. Companies of cyclists, and divisional telegraph companies were employed for the first time, also sanitary detachments. The tactics, and not the strategy, are criticized. Observations are made on each day's manœuvres and are decidedly instructive. It is noteworthy that the artillery of this corps has not yet been provided with sights for indirect laying.

November, 1912.

THE BALKAN WAR.—The article begins with a short summary of the causes of the war, and then proceeds with a description of the organization, composition and strength and armament of the army of each of the combatants. The theatre of war is then discussed at some length. A further article is to follow.

SOME REFLECTIONS ON THE ARMY MANŒUVRES OF 1912 IN FRANCE.—This is not a connected study of the operations, but only a few remarks on their conception and execution. The greatest secrecy was imposed, no communications were to be made to the press, and the greatest latitude was to be allowed to the opposing commanders. In spite of this it was well known some days before the manœuvres began where and on what days certain sections of railway would be crossed, and sketches were issued showing the zones forbidden to motorists unprovided with passes.

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It was observed however that many harmless sight-seers were excluded whilst others who had an interest in seeing what was passing, and who had better have been excluded, found ready admittance. The good will with which the civil population accepted delays in trains, and in the delivery of telegrams and letters and other inconveniences, was worthy of all praise, and shows how little the spirit of anti-militarism can have penetrated. The construction of certain boat bridges also indicated probable lines of advance, and limited the latitude allowed to commanders. A discussion then follows on the employment of umpires, or whether they should be allowed at all, also as to whether operations should cease for the night, or be continuous, and on the extent to which the Directing Staff should interfere, when unexpected situations arise, so that the operations should proceed as far as possible in harmony with the Director's scheme. The conclusion is that all are necessary.

The Director of the Manœuvres in his general idea omitted to say whether the inhabitants of the country were friendly or hostile, and the physical and moral states of the opposing troops. These are most important particulars and should always be mentioned. The general idea was issued some days in advance, a method that should always be followed. Orders for the day should not however issue from the headquarters of the Director, but from the headquarters of the fictitious Generals-in-Chief of whose armies the opposing forces are fractions. It is observed that the reports sent to the Director bear no resemblance to the reports and requests that would be addressed to the Generals-in-Chief, but no solution of this difficulty is suggested. The writer seems to consider that tactical exercises, based on a different special idea each day, would be of more practical use than manœuvres, so called continuous, which are really of necessity disconnected to some extent.

Details of Manœuvres.—A short criticism to be added to the report in the *Revue Militaire* of the manœuvres of the 3rd Corps, such as absence of intercommunication in some instances, insufficient reconnaissance during the battle, sections in the firing line omitting to support by their fire those advancing, failure to make use of cover, etc., with some observations and suggestions on the training of non-commissioned officers.

A. R. Reynolds.

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CORRESPONDENCE.

ECONOMY IN CONSTRUCTION.

DEAR SIR,

The article on "Economy in Construction" that appeared in the December number of the *R.E. Journal* appears to call for some remarks in so far as the paragraphs on "Factors of Safety" and "Moving Loads" are concerned.

In discussing the question of the deflection of bridges under a rapidly moving load has not the writer overlooked the element of time? In deflecting a girder, work has to be done, and the question of time and the inertia of the girder have to be considered. For instance between the coldest night in winter and the hottest day in summer we may assume that a certain girder expands 2 in. in length. It is evident that the question of time affects very largely the temperature stresses, for if an expansion or contraction of only half this amount were to take place in five seconds it is probable that the girder would fail under the forces applied to it.

Time is required to enable the molecules of any structure that is stressed to rearrange themselves and establish a state of equilibrium, and under a rapidly moving load the measure of the strain is not necessarily the measure of the stress. As regards impact the writer does not seem to distinguish clearly between "live" loads pure and simple, and live loads applied with impact. In the first case the multiplying factor to ascertain the *maximum* stresses (which will be *momentary*) ranges from 1 up to 2, according to the suddenness of the application of the live load; 2 being the mathematical factor for a load applied *instantaneously without impact*. Where impact is involved it is obvious that the necessary factor (*ceteris paribus*) will be higher than in the first case, and will vary under varying conditions, *e.g.* (1) a well-laid railway track, (2) a badly maintained macadam road carrying motor transport. Velocities being the same.

In the matter of Factors of Safety, (which is connected with the above,) it is stated that the Amir's engineer used a factor of safety of $1\frac{1}{2}$ "in calculating the strengths of road bridge girders" whenever he worried about one at all. On the face of it this appears to mean that he calculated on $18\frac{2}{3}$—$21\frac{1}{3}$ tons per square inch as his *working* stress for steel (the ultimate strength being 28—32 tons per square inch). If so, and his calculated loads come upon those bridges with any frequency, one may predict with some confidence heavy expenditure in maintenance.

Perhaps however the engineer meant that $1\frac{1}{2}$ was his factor of safety, applied to live loads, whenever he worried about one at all; and under the circumstances this would be justifiable, *vide* Part III., Sec. 2, para. 12, *Military Engineering*.

Yours truly,

H. BIDDULPH,
Major, R.E.

The Editor, *R.E. Journal.*

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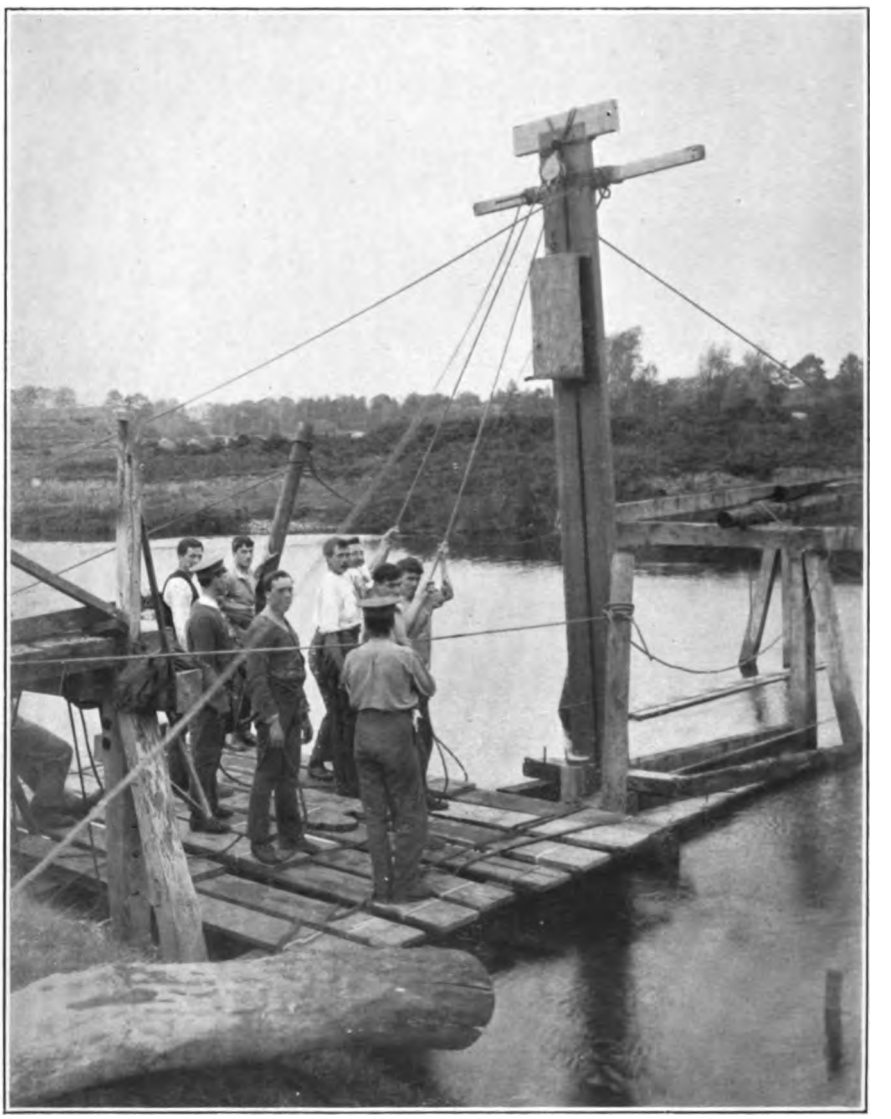
IMPROVISED PILE DRIVER.



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AN IMPROVISED PILE DRIVER.

By LIEUT. A. V. T. ROBINSON, R.E.

General Description.—The pile driver consists of two Weldon Trestle legs standing on a half-sleeper, as base, which is spiked to the platform or bridgehead on which the driver works. A cross-bar is lashed to the tops of the legs to support the monkey, which is worked up and down by means of a pulley block lashed to the cross-bar. The monkey consists of a block of wood, *200 lbs. in weight, through which two holes are bored to take iron bolts 2 ft. 3 in. long. These bolts work up and down between the Weldon Trestle legs, thereby keeping the monkey in position. The monkey has ½-in. iron bands round it, as shown on sketch. The pile driver is prevented from falling by four guys attached to any convenient holdfast.

Method of Fixing Up.—The Weldon Trestle legs are placed side by side on the head of the driver, fixed up and guys fastened. They can then be raised by the guys and shifted into position by mauls.

Number of Men.—The monkey can then be put on. Six men will put up this pile driver in half an hour and get it into position. It takes four men to work it, and two reliefs are required; so that the whole detachment for working should consist of a N.C.O. and eight men.

Detail of Stores Required and How Carried.—The following are the stores required for the pile driver:—

(*a*). *Carried in Company Equipment.*

2 Weldon Trestle legs.
Blocks 2-in.—1.
Lashings 2-in.—12.
Pickets 5-ft.—4.

(*b*). *To be Made and Carried with Company in G.S. Wagon.*

2 half-sleepers halved for W.T. legs.
2 ⅞-in. bolts 2 ft. 3 in. long with nuts and plates.
Iron band ½ in. wide, ¼ in. stuff, 10 ft. length, for monkey.

The total weight of these stores would be about 28 lbs.

* This weight can of course easily be increased.

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(*c*). *Monkey.*—A spar 3 ft. long and 15 in. diameter—weight about 200 lbs. This would not need to be carried as it could probably be obtained locally.

Results Obtained.—A good deal of pile driving was done with this machine last summer. Twelve piles 8 ins. × 8 ins. and 9 ft. long were driven. The detachment consisted of a N.C.O. and eight men. The average time taken was one hour per pile—this included fixing the pile driver each time and placing the pile in position. Each pile was driven in 5 ft. to 6 ft. and the time taken in actual driving was half an hour per pile. The bed of the river was of gravel, and at a depth of 3 ft. some hard rock was usually met with. The *Plate* shows details of pile driver and the photograph shows it at work.

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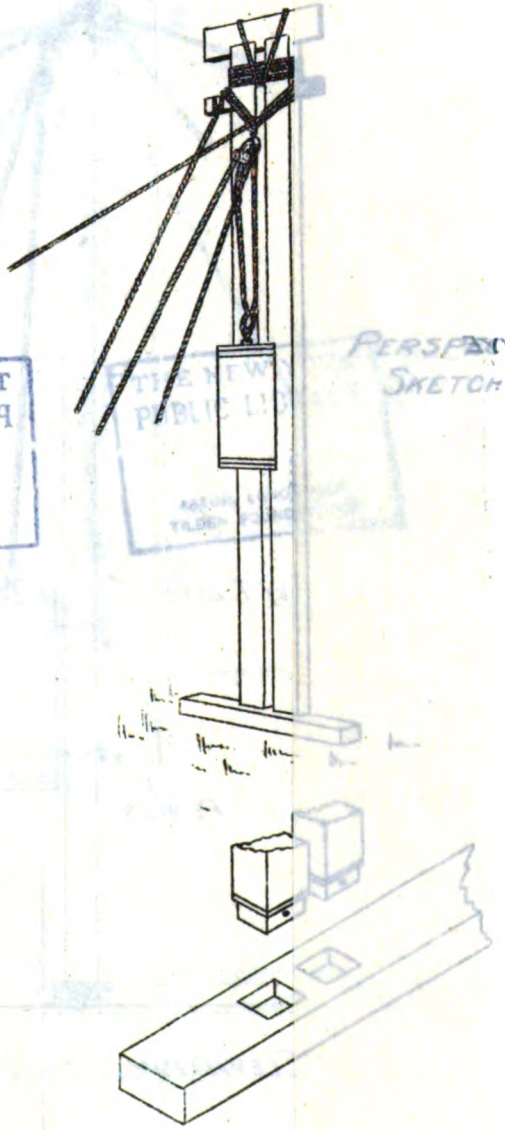
...ISED PILE DRIVER.



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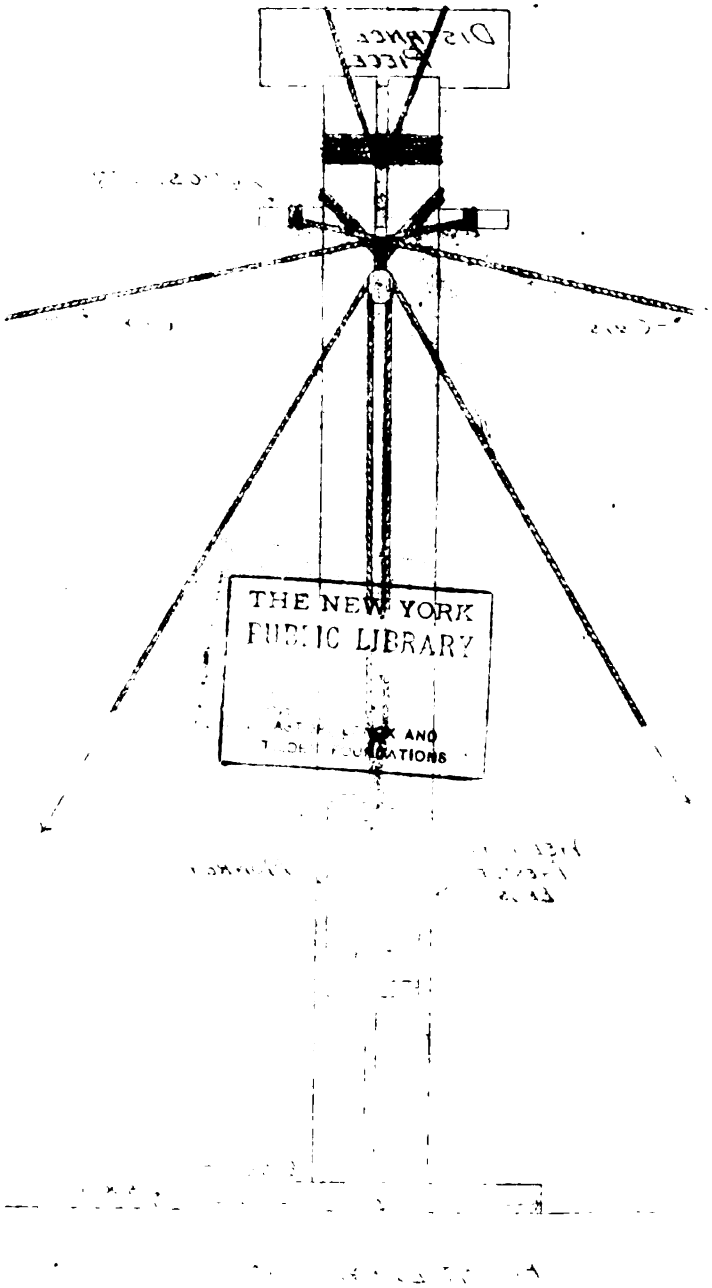
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Photo 1.—Training Works on April 19th, 1912.

Photo 2.—Showing the Area KIH.

Photo 3.—Showing Area LHIF (Connaught Bridge and Chakdara Fort in background).

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TRAINING WORKS IN THE SWAT RIVER.

By Capt. F. C. Molesworth, R.E.

This article is an attempt to describe certain training works carried out in the Swat River during the years 1908–12, in order to prevent the river from damaging the metalled Malakand-Chakdara road immediately south of the Connaught bridge at Chakdara, N.W. Frontier of India.

This bridge was built in 1901–03 by Lieut. (now Major) H. Biddulph, R.E. A very full and interesting account of its construction is given in Vol. XXIX. of the *R.E. Professional Papers*, 1903. The bridge allows wheeled vehicles from India to cross the Swat River, which is otherwise always impassable for carts, and unfordable during a large portion of the year for men and animals. Its value therefore for ordinary traffic is evident, and it is plain that in the case of military operations N. of the Swat River it would be of vital importance.

The constructional details of the bridge do not concern us, but it is advisable to note a few of the levels of various parts of the structure. The roadway is 2,255 ft. above sea level; bottom of girders, 2,250; tops of piers, 2,248; bottoms of piers, 2,200, except No. 5 pier, which goes down to a level of 2,194 ft.

The Swat rises somewhere west of the great bend of the Indus near Chilas. After a course of about 100 miles, it reaches Chakdara. It is to a great extent a snow-fed stream, and in consequence is much bigger in summer than in winter. Its level in winter may be taken as averaging 2,230 ft. (taken on pier No. 5, *vide Plate* I.).* About the end of March, it begins to rise, slowly at first, then rapidly during April and May, and generally with fluctuations following almost exactly the temperature curve. In June and July its normal level is about 2,236, after which it begins to fall, until in October its normal winter level is reached. Floods, raising the level by 4 or 5 ft., may be expected at almost any period of the year, but naturally those occurring in spring and summer are most to be dreaded. The highest known flood level is 2,243, in August, 1899; but observations of any kind date back only to the British occupation in 1895, and accurate daily readings have been taken only since the completion of the present bridge in 1903. It is not expected, however, that any flood would rise much above 2,243, which is practically the level of the surrounding country. The water rises extremely rapidly, 2 or 3 ft. an hour being not uncommon; the fall is characterized by what may be

* Readings taken on other piers vary sometimes by as much as 3 ft.

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termed "concertina-ing," from the appearance produced in a chart, since the main flood is often followed by smaller ones until the level gradually subsides.

Upper Swat being a closed country, floods occur without much warning, and barometric conditions in the Swat Valley are found to be very misleading.

When the girder bridge was constructed, certain training works were carried out, details of which are given in *Plates* V. and X. of Major Biddulph's article. These, it will be noticed, consisted largely of dry stone bunds (dams or embankments) laid practically on the surface of the ground, it was for this reason that they could never resist underscouring, which is the main danger to be faced. It may be remarked that the trees sown between the bunds grew to maturity in a few cases only; there are now scattered clumps over this area.

As it was, these bunds effectively protected the south approach until April, 1908, when, as the result of a flood (2,242 ft.), the river took a decided set over to the left bank and the wing walls of No. 6 abutment were breached. In August of the same year, a very heavy flood topped and undercut No. 2 bund, and both wing walls were undermined. The damage was repaired, chiefly by means of wire nets, locally known as *jalas*, filled with stones and tied up with thin wire. Some attempts were made to cut channels for the river so as to make it flow between piers Nos. 3 and 4. Some piles were also driven in in front of abutment No. 6.

Not much damage occurred in 1909. The river closed one of the channels, but deepened the other (Middle Channel). However, ½ mile upstream, it was working further and further north in the neighbourhood of Chakdara village, and, impinging from that bank, was coming almost diagonally across its former course and bearing very heavily against the south abutment.

In the hot weather of 1910, further damage occurred. Towards the end of July, a series of heavy floods carried away No. 2 bund for some 200 ft. above the abutment, destroyed the wing walls between the bridgehead blockhouse and the abutment, and so breached the road between these two places. Communication by road was therefore cut between Chakdara and the rest of India. Great anxiety was felt for the safety of the blockhouse, the foundations of which go down to 2,230, and the depth of scour in the channel was very much greater than this. Local labour was, however, procured in great quantity; stones were obtained by dismantling the upper parts of bunds 2, 3 and 4, and further erosion was prevented. A trussed timber bridge was thrown across the gap, and communication was restored. A spur was made out into the stream at the end of bund No. 2, and though this was considerably battered, no more damage occurred below it. The state of the channels during the ensuing cold weather is shown in *Plate* I.

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The following works were then undertaken :—

1. A guide bank was constructed from the end of bund No. 2 to abutment No. 6, and from thence to a point 100 ft. below. This bund was 40 ft. wide at bottom, 2 ft. wide at top, and about 20 ft. high. It was made of *jalas* up to cold weather water level, and of boulders faced with *jalas* above that.
2. Middle Channel was deepened.
3. In order to throw the stream into Middle Channel, three strong **T**-shaped bunds were constructed on the left main bank, ¼ mile upstream of the bridge.

The guide bank and bunds are shown chain-dotted in *Plate* I.

In March, 1911, an almost unprecedented rainfall occurred in the Swat Valley about Chakdara. It rained almost without intermission for ten days on end. The floods caused were not of any great severity, but higher up the valley and on the surrounding hills the precipitation took the form of snow, and in consequence the level of the river owing to melting snow was extremely high during the following hot weather, one of the hottest ever known in these parts.

On June 13th and 14th, 1911, heavy rain fell, and the river rose to 2,238·5. The stream, meeting such a powerful obstacle as the **T**-bunds, set to work to get round their shoreward ends, and succeeded to such an extent as to form a new channel (see *Plate* II.) behind them. The stream was now at liberty to attack No. 2 bund higher up than before, which it did with such effect that the junction of No. 2 bund with the new guide bank was washed away, and a raging whirlpool was formed on the spot where they had been.

It was evident therefore that the blockhouse and the communication between it and the abutment were in imminent danger. There was no Garrison Engineer at Malakand at the time, but efforts were made by the Political Agent, some officers of the Chakdara garrison and the local Military Works establishment to keep the flood away from the foundations of the blockhouse, and the flood subsided without any damage occurring.

On the arrival of the Assistant C.R.E. Nowshera District, and of the G.E., it was decided to abandon the old line of No. 2 bund and the guide bank, which indeed was now the centre of a torrent, and to construct a temporary bund on a curved alignment behind it (see *Plate* II.). Time being limited, the bund was made on no definite plan, *jalas* being merely thrown or placed in position, until the height of the remainder of the guide bank and No. 2 bund was reached. There was very little wire in stock at Chakdara, and in consequence application was made to the Telegraph Department, which most kindly supplied a large quantity at once. The greater part of this work was finished early in July.

The hot weather of 1911 was fortunately one of very little rainfall,

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and consequently there were no large floods. Underscouring began about the middle of the new curved bund about July 20th ; it took a dangerous tilt outwards, which was partly remedied by throwing *jalas* into the stream at the place in question. On the night of August 1st—2nd, there was a flood up to 2,238, and some ten yards of the bund fell forward into the stream ; this was repaired in a few days, coolies working night and day for the purpose. On August 29th, the river rose to 2,237·25, without damage occurring. On September 11th, with a slight flood of 2,235·25, another portion of the old guide bank collapsed by sinking gently down into the hole formed below it by underscouring. This, however, was the last damage done. The river was now falling steadily and its normal cold weather level was reached about the middle of October.

Attempts were begun in September to divert the river down Middle Channel again, and for this purpose a bund (not shown in the *Plate*) was made diagonally across the stream on the site of one of the old **T**-bunds, which had now practically disappeared. The bund was made about half-way across the main channel. Ploughing up the shoals was also tried, but the small native ploughs had little effect on the hard, large shingle, and the experiment was soon abandoned. Attempts were also made to get rid of obstructive shoals by explosives, but it was found that only very small craters, which speedily filled themselves up with shingle, resulted.

The direction of the channels during the cold weather of 1911–12 is shown in *Plate* II. The situation was extremely serious. The main current was pointing directly towards the south approach road, from which it was separated only by a bund, hastily constructed, which experience had shown was liable to underscour, and a few yards of soft loose earth, which would be eaten up by a heavy flood in a very short time. Not only was this part of the road in danger, but the whole 3 miles between Amandarra and the bridge lay close to the river, and a re-alignment further south on expensive rice land might have become necessary : a state of affairs which the lengthening of the bridge by a span or two might not have improved. In addition, a pothole, 15 or 20 ft. deep, had formed just in front of the old guide bank above the south abutment.

The C.R.E. 1st (Peshawar) Division, on one of his inspections, ordered the bank from I to F (*Plate* II.) to be revetted, and this was done by driving in piles, 3 or 4 ft. in front of the bank, and filling the space behind with *jalas* and loose boulders.

A very similar case had occurred at Kalsi on the Jumna in 1904, and the Director-General of Military Works, on receipt of proposals for training works in the Swat River at Chakdara, directed that the G.E. Malakand should go to Kalsi to study the system employed there.

Kalsi is situated at the point where the Jumna leaves the hills. The river is about the same size as the Swat at Chakdara ; like the

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Swat, it is largely a snow-fed stream. The general conditions are very similar to the Swat, except that on the left bank, which we are considering, the *kadir*, or area outside which the river cannot wander, is bounded by a line of cliff 30 or 40 ft. high, thus differing from the Swat, where the river might wander to an almost indefinite extent.

The Jumna is here bridged by a suspension bridge, 520 ft. long, on the Sharanpur-Chakrata road. In 1904, the flooded river breached the approach road on the south (left) bank, leaving the bridge almost high and dry. It was at first proposed to abandon the site altogether, and erect a bridge elsewhere, but this was objected to on the score of expense and for other reasons, and the matter was put into the hands of the late Mr. Denehy, P.W.D., who devised training works, at a cost of slightly under 1½ lakhs of rupees, which so far have served their purpose admirably.

In the first place, "Bell" bunds (named after the designer) were constructed perpendicularly to the bridge from each abutment. Then a bund was built from the left abutment to the cliff bounding the *kadir*, from which smaller and lower bunds projected upstream, the approach road ran along part of this bund. Thirdly, a large T-bund was constructed parallel to the bridge and about 500 yards below it. The main works were all several feet above highest flood level. Where exposed to the action of water, they were faced with masonry, laid in blocks about 20 ft. long, with spaces of about a foot between each, so that the settlement of one block would not necessarily injure the rest of the bund. At the foot of these were laid blocks of masonry about 10 ft. by 10 ft., articulated in a similar way. The foundations went down to no great depth, as the masonry blocks in front protected the foot from scour; these blocks of course had frequently to be renewed, but as a rule they lasted out a whole flood season. Wire *jalas* were used much more sparingly than at Chakdara.

The object of these works was to provide "still-water areas," above and below the bridge, in which silt should be deposited and eventually a firm bank be produced. This end has been attained in a most successful manner.

Now comes the application of these principles to Chakdara. The first desideratum was a Bell bund perpendicular to the bridge, and this it was decided to make in continuation of the old guide bank (see *Plate* II.). The position of the upstream end was fixed by the mouth of Walsh Creek. This gave a total length from the abutment (including the existing guide bank) of 600 ft. Its nose, the most important part, would be constructed partly on the south shore of Martin's shoal, consequently largely on dry land, a very great advantage. The upstream end of this bund was to be faced with masonry, and the toe protected by an apron of masonry blocks in the same way as at Kalsi. Another Bell bund was to be made below the bridge, for a distance of 150 ft., in continuation of the guide bank,

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itself 100 ft. long, and in a very good state of preservation at this point. But as the river had shown few signs of getting round this way, it was proposed to leave this part of the work to the last. There was of course no question of taking the foundations of these bunds below ground level. If scour took place the apron would subside, and it would be a comparatively simple matter to rebuild it to original height; thus it was hoped that the main bunds would remain intact. A second bund, at right angles to the first, was, of course, necessary. At Kalsi, this was actually in prolongation of the bridge; but to do this at Chakdara would have meant the abandonment of a large area of cultivable land to the action of the stream. The position HIJ was eventually chosen, 350 ft. from the road. There was no unscourable cliff within easy reach, as at Kalsi, to form a *point d'appui* for this bund; in fact, it would have been necessary to take it about 1½ miles south to get to firm soil; so the Thana road was fixed as the south limit. Beyond this there was a slight rise, and to take it further would have meant the acquisition of rice land at a heavy cost.

Lastly, what may be described as an outpost line was designed. The object of this was to close the upper ends of Edgell Channel and the other channels, and so protect the main works during construction. This line consisted of a series of bunds, beginning at a place on the left bank about a mile above the bridge where there was a low earth cliff, and crossing every channel between there and Grassy Island. From this point a bund was to be built right across the main stream to Martin's shoal, which bund, it was hoped, would have the effect of diverting a large portion of the stream down Middle Channel. These bunds were of slight construction, nowhere more than 8 ft. high and 8 ft. broad. It was not expected that they would stand the summer floods, but it was considered that they would sufficiently protect the bunds nearer the bridge during building. At certain places on this line, as well as near No. 3 bund, trees were to be planted.

The estimate was sanctioned in full by the D.G.M.W. on March 6th, 1912. Certain parts of the work had been put in hand previously, in anticipation of sanction, the outpost line was nearly complete, and a very large stream was already flowing down Middle Channel, also the revetment FI was almost finished.

The first difficulty experienced was in getting labour. Only one piecework contractor was obtained, and he showed a marked preference for bund making on dry land. But a contractor was obtained for the collection of boulders, and the bulk of the actual construction had to be carried out by daily labour. The Political Agent very kindly procured some 250 to 300 coolies from the neighbouring villages—it must be remembered that Chakdara is beyond the administrative border, and that consequently labour for Government works is sometimes difficult to procure. These men were paid eight annas a day.

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Work was now begun on bunds IH und KH, by throwing in *jalas* from the banks. The masonry facing was also started on bund HL, materials for which were dumped down from the bridge on to Martin's shoal, and then carried across by coolies. The river, however, began to rise almost immediately. It soon reached the foot of the masonry, and washed out the mortar, which had not yet set, from the interstices. Tarred bags filled with cement concrete were then placed as foundations, and attempts were made to build the masonry on this, but the river continued to rise (a good deal of rain falling in March, and consequently causing floods) and it soon became evident that the masonry facing would have to be left to the next cold weather, the bund meanwhile being constructed of *jala* work.

The progress of bund IH, combined with the rise of the river, now formed a deepish channel along the north side of HL, and made it impossible to convey stones from Martin's shoal. Some rafts of inflated skins were therefore made up, and stones were ferried across from the mouth of Walsh Creek. This method was of course extremely slow.

Bund IH was meanwhile progressing. As it advanced, however, it dammed up the water in the area FIHL, and it became necessary to heighten it continuously, in order to prevent it being submerged. On some days all the available labour had to be put on to heightening it, so that bund-head did not advance by a foot. Moreover, as the space between bund-head and HL narrowed, the rush of water became stronger and stronger, and *jalas* thrown in seemed to be whisked off downstream and lost for good. It seemed as if the gap would never get closed.

Bund KH was meanwhile getting on, for the difficulties were not so great. Progress was slow, owing to the great depth of water (about 18 ft. close in to the shore).

Early in April one or two floods occurred, rising to 2,232·75, and the works were almost entirely submerged, fortunately with little damage.

On April 15th, a bridge was thrown across between IH and HL, which made it much easier to get stones on to the latter; the service of rafts was forthwith dispensed with. *Jalas* were now lowered into the stream simultaneously from both sides of the opening, which now rapidly closed. At last, on the evening of April 17th, amid a scene of great excitement among the workmen, the two bunds finally met. The level of the river on that day was 2,231·50.

It remained to close up bund KH. This gave little difficulty, as in the middle the water was very shallow.

By now, practically the whole of the shoals in the river bed were under water, and so stones for *jala* work could not be obtained from them; however, the contractor agreed to procure stones from the hill west of Chakdara Fort at a rate of Rs.3.8.0 per 100 cubic feet.

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The D.G.M.W. inspected on April 19th, and sanctioned the substitution of *jala* work for masonry, as a temporary measure. The aspect of the works on that day is shown in *Photo* 1.

Work being now well above water level, it was possible to keep to the proposed sections, and so the upper part was much more regular in appearance than the lower. Bunds IH and HL were completed towards the end of May, and then IJ was constructed. Bund KH was left about 4 ft. lower than the other bunds. Work was finished early in July, by which time the river level was 2,236. It was decided to leave the proposed continuation of the old guide bank west of the bridge for the present, as the river showed no signs of bending round that way.

At first water poured through the bunds with very little check, but, as floating matter collected, they began to pond up the water, until the difference of level on the sides of IH was nearly 4 ft. The area KIH made an excellent swimming bath, for which purpose it was used by the officers of the garrison.

The bund across the main channel was breached by floods early in May, and from that time onward the flow down Middle Channel decreased.

The beginning of July was hotter, it was said, than had been known for 30 years. This accounts for the high level of the water. There was a slight flood on July 5th, due to rain in Upper Swat, and a small piece of the apron at L subsided; this was quickly repaired.

On the night of July 12th—13th, about 3 ins. of rain fell, and as a result, the river rose from 2,237 to 2,240·5 ft. between 7 a.m. and 1.30 p.m. About 2 ft. of this rise occurred between 11 a.m. and 12 noon. This, it will be noted, was 2½ ft. only below the record flood. At its highest point, it reached within about 2½ ft. of the top of bund JH. Bund No. 2 was topped, and the whole area between bunds Nos. 2 and 3 was under water. At one time, the flood got round the end of bund JH at J, and for about half an hour ran along the Thana road in a stream about 6 ins. deep. Most of the area west of KIJ was 2 to 3 ft. deep in water, but this water was practically still, so that nothing approaching erosion occurred. The top of bund KH was just awash.

At the highest point of the flood, practically the whole of the river bed was covered. On the north bank, the water even entered the Station Garden. No damage occurred to the main bunds. A slight further subsidence of the apron at L was noticed when the flood subsided. At 1.30 p.m. the flood began to diminish, and though there was a slight rise later in the afternoon, by nightfall the level was 2,238. Early the next morning more rain fell (at Malakand 6 ins. were registered in six hours) and the river rose to nearly 2,239.

The next three weeks were very rainy, and floods were constant. About this time an island of silt appeared above the surface in the

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area KIH. This was a hopeful sign, showing that the still-water areas were fulfilling their purpose.

On July 29th, the river rose to 2,240, a rise of 3 ft. taking place in less than an hour, but falling almost as rapidly. On July 31st and the two following days, the river reached 2,238·5, 2,239·5 and 2,240. The maintenance of such high levels was unprecedented.

Some damage occurred to the revetment between F and I, but the bank behind was not affected. It was noticed that, whereas in the earlier floods the water had swept round the head of L, the tendency now was for the main stream to cross what had been Martin's shoal diagonally, and to strike bund HL obliquely; some damage occurred as a result to the apron along the north side of this bund. The stream in front of L became relatively insignificant, and gave no more trouble.

The flood of August 2nd was the last serious one. The river now began steadily to fall, and by the end of September had reached its normal cold weather level.

The direction of the channels, and positions of the shoals at this time is shown in *Plate* III. It will be seen that the area KIH was almost entirely silted up, and the area LHIF partly so. Silt to a depth of 6 or 9 in. had been deposited over the area between bunds Nos. 2 and 3. A large shoal had formed on the north side of KH, and below this point, where a pothole some 15 to 20 ft. deep had existed the previous cold weather, silt had been deposited to within 2 or 3 ft. of the surface, and the water was practically stagnant. By far the greater part of the current was now running between piers Nos. 4 and 5. Middle Channel had closed up, and North Channel was nearly still, being fed solely from irrigation streams.

Higher up, it will be seen that the outpost line had remained nearly intact, except the long bund between Grassy Island and Martin's shoal which was practically quite destroyed. It will be noticed that the main channel north of these bunds does not approach Chakdara village nearly so close as before.

Tree planting was successful about bunds Nos. 2 and 3, but not so higher up, where the young trees were inaccessible for some months, and so got choked up with weeds.

Although, during 1912, the record flood was not equalled, yet five floods, exceeding the average highest summer flood, occurred within three weeks, and the resulting damage to the training works was small. The results of the first season's experience may therefore be said to be satisfactory. The danger spot, which may now be said to be about L, has been removed some 200 yards from the bridge, and the threatened south approach has been protected by several vertical feet of sand and shingle which it would take a great deal of erosion to get through, and it appears, at present at any rate, that the set of the channels does not conduce to erosion on this side.

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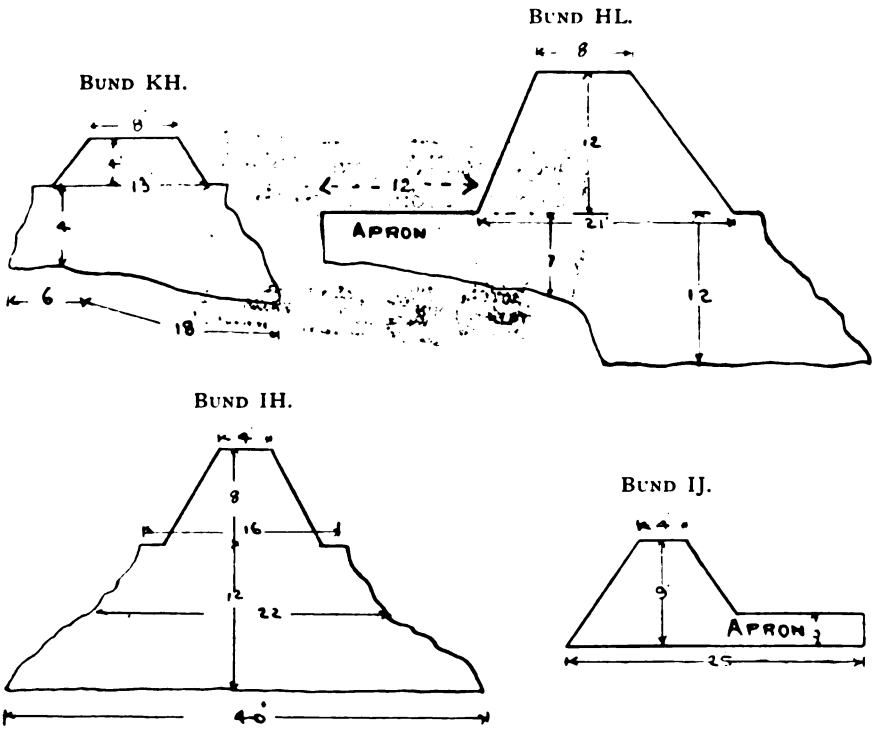
The "lessons" therefore of Kalsi and Chakdara may be summarized as follows :—

1. Protection works in the neighbourhood of the bridge are of greater value than those higher up the river.
2. Bunds should be perpendicular or parallel to the stream; oblique bunds nearly always fail by underscouring.
3. Cutting channels for the river is usually a waste of labour.

It is not intended to suggest that these lessons are applicable to all rivers.

It may be added that the *jalas* so often referred to were made up locally with wire ($\frac{1}{10}$ in. dia. was found to be the best, bound with $\frac{1}{32}$ in. dia.) in 6-in. meshes. Each *jala* was 8 ft. × 8 ft., and took eight coolies an hour to prepare.

On October 25th, 1912, the D.G.M.W. and C.R.E. inspected, and ordered that bund KH was to be brought up to the same height as the other bunds.



Sections of bunds KH, HL, IH and IJ, as finally constructed, are shown in the above figures. The difference in the regularity of the sections above and below water level (at the time of construction) will be noticed.

The cost of the training works carried out in 1912 was about Rs.70,000.

Photos 2 and 3 were taken in October, 1912.

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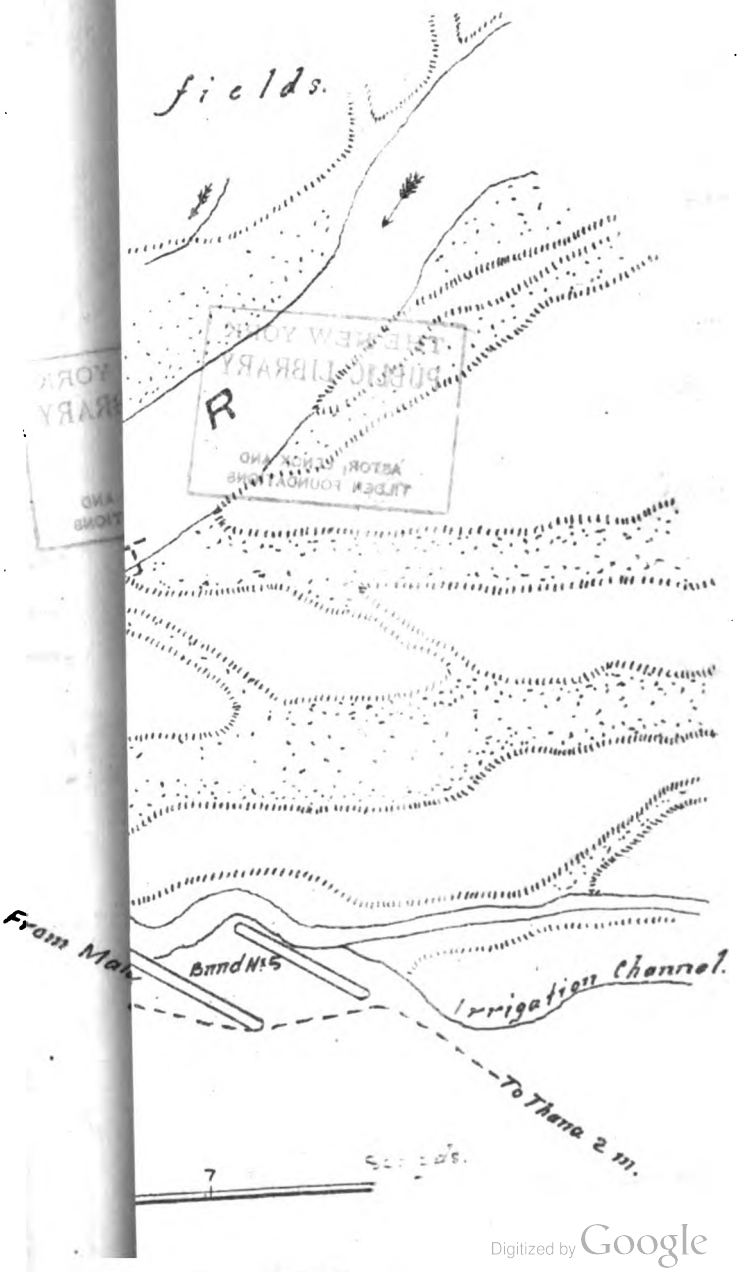
PLATE I.



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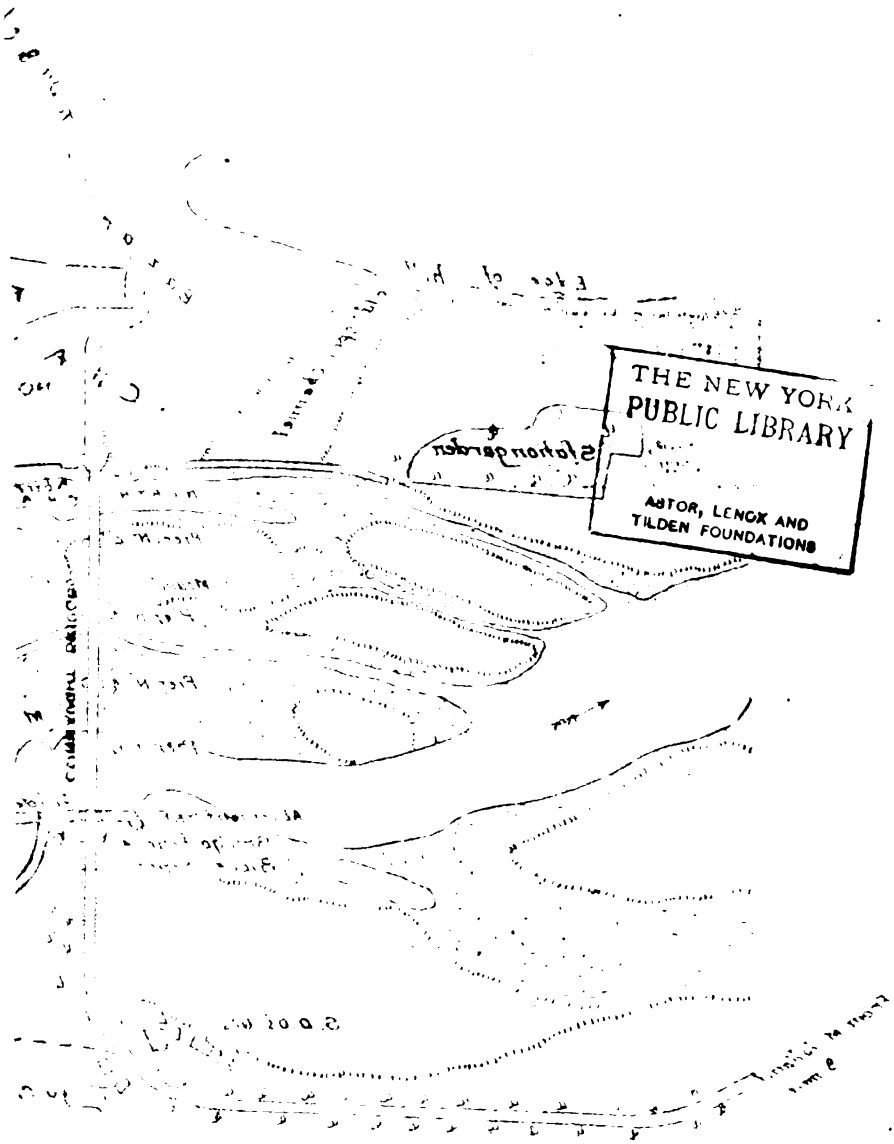

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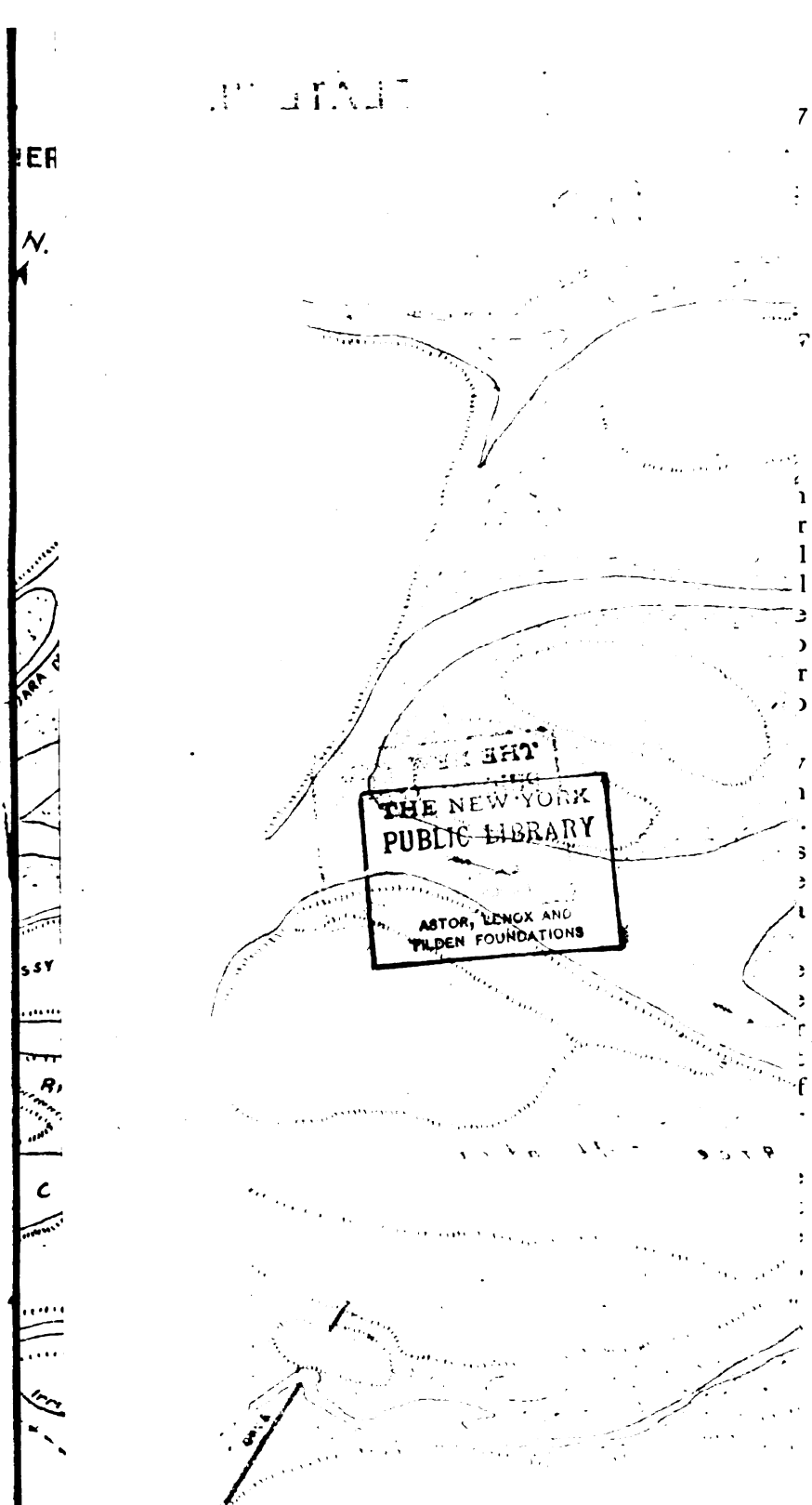

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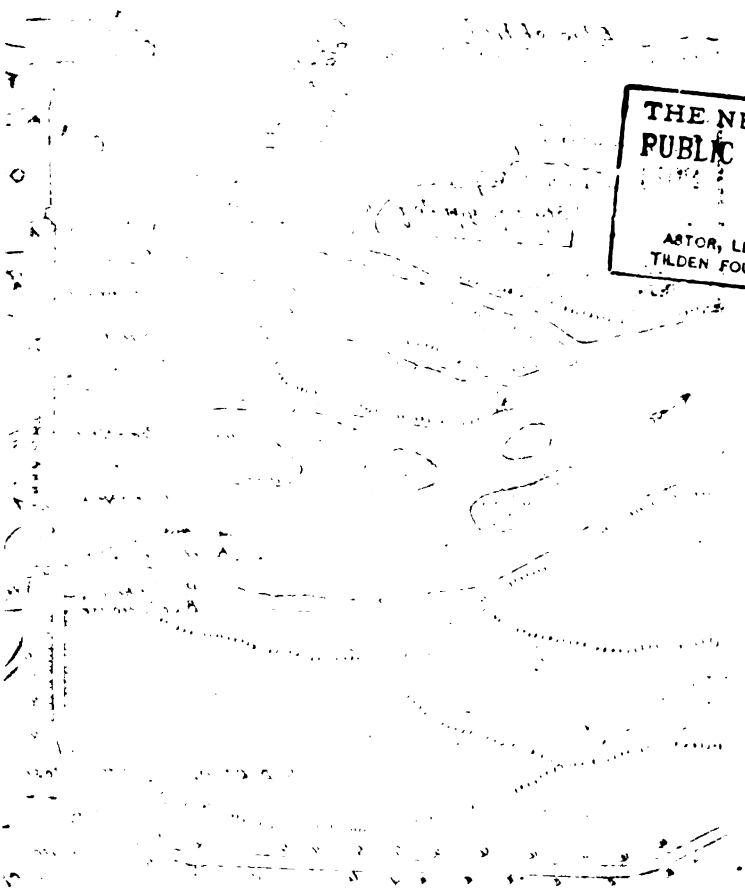

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*THE INTERNATIONAL ONE-IN-A-MILLION MAP OF THE WORLD.**

By ARTHUR R. HINKS, ESQ., M.A.

THE first sheets of the international map have been published within the last 12 months, some 20 years after the first proposals for its construction were made by Professor Penck at the International Congress of Geographers, meeting in 1891 at Berne. The real beginning of this enterprise marks a new era in cartography; and the study of the first sheets raises at once some questions which seem to me not only of interest, but of immediate interest, not unsuitable for discussion on an occasion when I am honoured by an invitation to address the officers of the S.M.E.

Geographical Congresses may have pious aspirations; they may embody those aspirations in diplomatic memoranda, which approach the Governments of the world through the most august channels. Yet it has happened that such representations will pass over the heads of a government department as unheeded as the time signals from the Eiffel Tower, unless there is installed somewhere in the executive a detector and a capacity attuned to these propaganda.

The Congress of Berne appointed a commission to examine the project, and to report to the Congress of London in 1895. The Congress of London adopted a series of general resolutions in favour of the scheme, and to some extent cleared the ground by agreement on an initial meridian—that of Greenwich—and on a method of dividing the world into sheets. Then the scheme went to sleep for 13 years.

In 1908 it was revived at the Congress of Geneva, and more resolutions were passed. But there seemed to be every chance that these would remain as inoperative as their predecessors, for the Congress had no executive power to carry them into effect. But, very fortunately for the realization of the scheme, the Geographical Section of the General Staff had been represented at Geneva by its Chief; and it will not seem far fetched if we trace a connection between this fact and the realization by the British Government that the proposals would remain inoperative unless officially adopted.

* A lecture delivered at the School of Military Engineering on October 17th, 1912.

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The British Government therefore issued invitations to the Governments of the world to send delegates to an official committee, which should discuss the question of standardizing the international map, and should make definite recommendations.

This Committee met in London in November, 1909, and found that the preliminary discussions had so far cleared the ground that it was able not only to adopt a detailed scheme, but to adopt it with unanimity. There was, in fact, only one question which might have been difficult, the choice of the unit for the representation of heights. Divergences in the national units of distance cause no trouble, for it is the easiest thing in the world to provide a map with two or more scales of length. But the unit of height governs the placing of the contours, and one cannot have alternatives. It will be generally agreed, I think, that the representatives of Great Britain, Russia, and the United States did well to accept the metre which must have been used by all other countries.

I do not know that any very definite statement has ever been made of the precise purpose of this map. The scale of one in a million is intermediate between that of atlas maps and that of the smaller topographical maps—a little bulky for a reference atlas, a little small for the purposes of administration or strategy. We may think of it, perhaps, as meant for the use of the systematic geographer, whenever it shall have been determined what is the function of that person, and if indeed he has survived the destructive effect of Colonel Close's address to the British Association at Portsmouth last year. But whatever its purpose, the leading principle of the map is clear. It is to represent the whole world by a uniform notation, every sheet written in the same language, without difference even of local idiom, so that who learns to read one sheet may read them all without rearranging his ideas. One set of conventional signs, one scale of altitude tints, is to serve for crowded Holland below sea level, for the spacious plateau of central South Africa, and for the terrific region which bounds India on the northern frontier. It was a bold conception, that these diversities could be brought within the grasp of a single characteristic sheet. When we remember that three years ago there was no example in existence of an elaborately colour-printed map on this scale, we may admire the courage of the committee which adopted a whole series of binding resolutions; but we cannot admit that discussion is closured.

On the contrary, I would submit to you that this is the epoch at which discussion may begin with profit. Five sheets of the map are now published—two by the Ordnance Survey, of northern Scotland; two by the Geographical Section of the General Staff, of European Turkey and of N.W. Cape Colony respectively; and one by the Service Geographique de l'Armée, of N.E. France and adjacent countries. I will ask to be allowed for the moment to treat

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these sheets as experimental, not definitive, and to discuss the measure of success achieved in view of the restrictions under which they were produced, the restrictions, I mean, of an inelastic set of rules giving little scope for modification to suit the peculiarities of each sheet.

Let us begin by noting the points in which they have scored a conspicuous success. There are two at least—the styles of the lettering, and the spelling of the place names.

Many attempts have been made to distinguish between features of different kinds by differences in the character of the lettering which is attached to them ; and many of the attempts have failed because in the effort to obtain distinction of character there has been a sacrifice of legibility. The use of "Roman" for towns, and of so-called "Egyptian" for physical features such as capes and mountains, makes a clear distinction in clear type. And the characters are solid, not of that evanescent fineness that has been the stupid ambition of too many draughtsmen in the last 50 years. It is to be hoped that in style of lettering these maps will serve as an example to all future cartographers.

The spelling of the place names follows the official spelling of the country represented, not the habitual spelling of the country producing the map. The Italians, it has been remarked, "call Florence Firenze :—so curious of them!" The international map calls Philippopolis Plovdiv ; the Dardanelles are Ak Deniz Boghazi (with the more familiar name in brackets as a help to the infidel) ; the sheet margin gives a glossary for the pronunciation of Rumanian, Turkish, and Bulgarijan ; for Chinese names we are promised the system of transliteration adopted in the post and customs service ; and it is supposed that the Ordnance Survey will publish a guide to the pronunciation of English, Welsh, Scottish, and Irish place names in four or more volumes. These niceties lend a scholarly air to the map, and make each sheet a liberal education.

A hard-and-fast division of the world into sheets covering 6° by 4° must necessarily produce many awkward cases of separation. England suffers especially because she has the honour of providing the initial meridian, which puts London on the edge of a sheet ; and also because in the relatively high latitude of our islands, while the longitudes have shrunk so that the 6° are in breadth little more than two-thirds of the 4° in height, we just fail to come under the rule which allows a doubling of the longitude extent north of 60° in latitude. The effect on the north of Scotland is disastrous : the Western Hebrides are relegated to a separate sheet which is nearly all sea. The Shetlands, north of 60°, will grace the southern edge of a sheet twice as broad as the north of Scotland sheet. We

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may be allowed to think that each map-producing country should take the liberty of interpreting the rules for the sheet margins in a broad spirit, allowing even considerable overflows wherever they seem to be desirable. Kent and Essex appear on the Paris sheet, but that does not seem to be sufficient reason why they should not be shown also as overflows on the adjacent English sheet.

Experience of another international enterprise which need not be specified seems to me to point to the following course of events as normal :—

The first congress draws up an elaborate plan, devised very largely by people who are not going to do the work themselves. This plan is made binding on all participants, in the most solemn and formal manner.

Some years later a second congress meets, and some of the members have experience of what happens when they have got to work. Further resolutions are made, with this difference, that participants are advised to follow them as nearly as possible.

A third congress meets when the scheme is really under way. It quietly approves and adopts many of the deviations from the letter of the law which experience has taught to be desirable ; and for the future it agrees that if anyone wishes to depart from the rules, no one will try to stop him. His blood will be on his own head.

But do not suppose that those pie-crust resolutions were futile. They played an indispensable part, in getting the enterprise started in an orderly manner. When they began to press they were lifted or cut ; and that, we anticipate, will be the future of some of the resolutions which were passed by the International Map Committee in 1909.

The resolutions in question are those concerned with the representation of the relief of the ground : the real difficulty in the production of a topographical map, and one of the most interesting problems which I have met. Moreover, it is practically a new one, for before the days of colour printing the methods were quite different and the possibilities far less. Within the last few years great improvements have been made in colour-printed maps, especially in the application of the layer system of colouring, and the productions of the Ordnance Survey and the War Office rank high among the successes in this field. But we may note that the hitherto published series of maps on the layer system have been mostly on scales from 1/100,000 to 1/250,000 and that no 1/M layer map had been produced at the time when the International Map Committee decided that their map should be coloured in hypsometric tints. If, then, we find reason to think that some things might be improved on this map, we ought not, I would submit, to appear vain critics of the *chose jugée*, but rather as men having a keen interest in first experiments in a new field.

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Whatever additions may be made, the basis of the precise representation of the relief must be contours. The resolutions of the Committee provide that

> Normally contours shall be drawn at vertical intervals of 100 metres reckoning from sea level. But in very hilly districts the contours may be at larger vertical intervals, provided that they are spaced at 200, 500, or 1,000-metre intervals. In very flat country additional contours may be inserted, provided that they are spaced at 10, 20, or 50-metre intervals.

In the four sheets published the contours are drawn as follows :—

Highlands.	Paris.	Istambul.	Kenhardt.
100	100	—	100
200	200	200	200
—	300	—	300
400	400	400	400
—	500	—	500
600	600	600	600
—	—	—	700
800	—	800	800
—	—	—	900
1000	—	1000	1000
—	—	—	1100
1200	—	1200	1200
—	—	—	1300
—	—	—	1400
—	—	—	1500
—	—	1600	1600

The Highlands sheet breaks into the 200 step very quickly: around the lochs of the west coast there is barely room for the 300 contour, and still less for the odd hundreds of higher denominations. The Paris sheet keeps to the regular hundreds, but makes no use of the suggested intermediate contours for the flat lands, though this sheet shows a good part of Holland, and nearly all Belgium. The Istambul sheet works in units of 200, thereby representing great stretches of country as featureless plain; also it transgresses the letter of the rule by making steps of 400 in the upper reaches, being driven to do so by an inconsistency in the official scheme. The Kenhardt sheet alone of the four progresses regularly by steps of 100 metres throughout, being able to do so by the nature of the country: high plateau, for the most part, but without excessively steep slopes needing very close contours.

Probably the Istambul sheet would be improved by the insertion

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of the 100 and 300 contours. For the remaining diversities there is good reason : good, at least, so long as the layer system of colouring is obligatory.

Turn now to the application of the layer system on the different sheets. Without the aid of colour it is difficult to express the significance of the variations we find ; but roughly the results are as follows :—

Colour.	Char. Sheet.	Highlands.	Paris.	Istambul.	Kenhardt.
Green	0—100	—	0—100	—	0—100
Pale green	100—200	0—100	100—200	0—200	100—200
Palest green ...	200—300	100—200	200—300	200—400	200—300
Palest yellow ...	300—400	—	—	—	300—400
Pale yellow	400—500	—	300—400	400—600	400—500
Pale brown	500—600	200—400	—	—	500—600
Light brown ...	600—800	400—600	400—500	600—800	600—800

Thus the Paris and Kenhardt sheets follow the strict rule in having three shades of green, up to 300 metres ; but the Highlands sheet has two shades of green, stopping at 200 ; and the Istambul sheet has also two shades, but stopping at 400.

In the yellows, which should be in two tints between 300 and 500 : Highlands has none ; Paris has one, 300 to 400 ; Istambul has one, 400 to 600 ; Kenhardt is correct.

By the characteristic sheet the brown tints should begin at 500 m. In the Highlands they begin at 200 ; on Paris at 400 ; on Istambul at 600.

We shall not, I think, be wrong in saying that in uniformity of application the layer system on these sheets has not been a success.

It is perhaps open to question whether there was real necessity for quite so much diversity as has appeared in the treatment of these lower layers, and it is a pity that for these first few sheets the rules were not in all cases carried out strictly, regardless of consequences. This may be regretted, I mean, from the point of view of a scientific experiment ; its effect on the appearance and saleability of the sheets is another question, with which, as topographers of an experimental turn of mind, we are not concerned.

But there can be no question, I think, that in mountainous country, even in the not very formidable mountains of the Highlands, the layer system is a complete failure for 1 M maps. To develop its effect a strip of any one tint must have breadth ; a strip less than 4 or 5 millimetres broad, enclosed between brown contour lines, loses recognizibility as a tint, and merely confuses the contours. The Highlands sheet shows this very well. Though the contour interval is 200 metres the horizontal distance between contours is

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less than a millimetre in many regions of the map ; the gradations of tint are obscured by the contours ; the contours are obscured by the tints ; and the result is a weak effect of no solidity.

All this is due to a principle which in other matters is well understood. If one wishes to produce a quiet and unobtrusive effect in dress one wears a coat which, when magnified, proves to be compounded of several violent colours in small doses. In gardening the sure way to produce a dull and undistinguished effect is to mix several varieties of tints. The same principle demands that the layer tints of a hypsometric map shall be in broad stretches, not in narrow interlacing strips, if any effect but that of effacement is desired. Yet it seems that this principle was overlooked when it was decided to make the 1/M map a layer map.

Consider the matter numerically. If the scale is 1 in a million, the contour interval 100 metres, how near are the contours together, on a slope of 1 in 10 ? The answer is 1 mm. But in places where the relief of the ground is the main topographical feature to be represented a slope of 1 in 10 is a moderate slope. It seems then that, if the contours are to be drawn close enough to represent fairly the characteristic shape of the hill forms, they must be of necessity much too close to give the layer system a chance of success.

This defect of the layer system is fundamental. It is quite good for ground of very moderate relief, as was seen in the early sheets of the O.S. half-inch map, covering the Southern and Eastern Commands. When the sheets of Dartmoor and the Lakes appeared, the effect was generally admitted to be horrible. But the blame was laid on the colour scale, which was much too heavy in the higher layers, and on the hill shading, which confused the due succession of tints. The colour scheme was modified, and the hill-shading omitted. I think that the Dartmoor and Lake sheets on the new scale have not yet appeared ; but I believe that we may predict that they will be disappointing because the layers will be too much interlaced and too narrow.

It may be said that the obvious remedy is to increase the contour interval in the higher ground, as is provided in the rules, and carried into effect in the sheets we are examining. But I think that the Kenhardt sheet alone is enough to show that this is a poor solution of the difficulty. It breaks down when the general elevation of the land is high, as in the central parts of South Africa. An elevation of a hundred metres is as topographically significant in the veldt as it is in Kent. The Kenhardt sheet shows the 100-metre contours throughout, but is restricted so much in the range of tints allowed by the rules that most of the map is coloured a strong shade of reddish brown, under which brown contours, red roads, and blue rivers are equally obscured. No scheme can be pronounced a success, I would

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submit, if it requires that broad stretches of the map should be heavily coloured, to the obscuration of detail.

We are faced, then, with two separate difficulties in the application of the layer system, its ineffectiveness when the slope is steep, and its crudity when the land is high. Let us consider them separately.

Wherever the slope of the ground is as steep as 1 in 25 its form is perfectly represented by contours, without layers. The layers are wanted in the shallower relief, where the contours are so widely separated that the eye cannot follow them readily. Let us see if anything can be done by confining the layer colouring to the shallow relief, and representing the steep ground by contours alone. This is not without something of a precedent, though not a close one. The Swedish map on the scale 1/100,000 has hachuring on the shallow slopes and contours on the steeper ground.

If this plan is to be tried it seems to require that the contour lines themselves shall be drawn in various colours; a device that has not, I think, been attempted up to the present. If it were possible to colour our contour lines on a finely graded system of tints like the layer system, nothing more could be desired; but this of course is not possible, because small differences of colour in a fine line cannot be appreciated, especially when the lines are isolated. But when the contours come close together their colour becomes appreciable, without interfering unduly with the legibility of names and detail. I would ask, then, if it is not worth while to try an experiment on this plan, perhaps as follows:—Adopt the colour scale of the international map as far up as 500 metres, that is to say, in the green and yellow; retain the layer system up to this point, but make the contour lines in these levels respectively green and yellow also. Above 500 metres turn the colour scale into orange instead of brown, and continue it through red, purple, and violet, allowing 1,000 metres for each colour. This would take us up to 4,500 metres, and provide for the greater part of the world. Above that height we might run into grey for rest. And it is very probable that a light grey shade with oblique light in the steeper country would add materially to the effect, without obscuring the comparatively small amount of detail in names that is found at those altitudes.

Now for the case of the high plateau. With the colour scale suggested there is no reason, except cost, why very light shades of the orange or of the red should not be applied as layers where it was desirable. In the Kenhardt sheet, for example, a pale orange tint, with stronger orange contours, would be much less obstructive to the general legibility of the map than the strong brown that at present covers it. As for this brown, I believe that it will be found on more extended trial that the adoption of brown was a mistake. One wants especially transparent colours, and this brown is not transparent.

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Moreover, it is contended that the layer system is the greatest success when the tints of the layers follow the order of the colours of the spectrum. It is even contended that there is a physiological reason why a transition from green to yellow is more agreeable and less violent than a change from green to orange or red. Whether or no this is good physiological optics, it certainly does seem to be borne out by experience that a progression in this spectral order is a good one. By far the most beautiful and effective layer map that we have is the 1/250,000 map of the Bavarian General Staff, in which this spectral order is more or less followed, though the purity of the colours still lacks something of the spectrum purity. The yellow is rather brownish.

When we have to deal with a high plateau it seems to be absurd that the rules require us to cover the whole sheet with a heavy tint of colour, which is giving us very little information for a great deal of obstruction. Some little while ago I ventured to suggest that in these cases it might be sufficient to run a band of the layer tint along the contour, leaving the remaining space between contours clear and unobstructed. I did not find that the idea commended itself to anyone else; and I am thinking now that it would be applicable to comparatively few cases. A high plateau is after all not often very flat; and it seems to me on the whole that the variously coloured contours here suggested as the standard way of printing contours for the whole map is the plan most likely to succeed. As to its cost, we are likely, I am afraid, to hear something from those who have to do the best they can with strictly limited funds.

Leaving now this most interesting but complicated question of the relief, let us look for a moment at other features of these sheets of the 1/M map. The roads, according to the characteristic sheet, are to be in red, in four different classes. In practice it is found to be impossible in a thickly settled country to show all these roads, and the Paris sheet frankly omits all but the roads of the first class. The Highlands sheet shows two classes of roads fit for wheeled traffic, and very occasionally a track not so fitted. But it is clear that the greater part of these tracks are necessarily omitted, and their omission leaves the reader with an exaggerated idea of the pathless state of Scotland. The red colour of the roads cannot be pronounced a success. On the green it looks poor, and on the brown it almost disappears. On the brown also a third-class road, denoted by a single red line, is suspiciously like a brown contour. It will be found, I think, that the red roads will be replaced by some other colour and it is possible also that the traditional double line will disappear. It would be interesting to experiment with grey roads.

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Time fails us to discuss the many other interesting points that arise when we begin to use these admirable maps and consider how far the aspirations of their projectors have been realized. If we have been critical, the criticism is meant in none but the kindliest spirit. Should it be held that any criticism is beside the mark, because the scheme of the International Committee is adopted and binding for better or worse, then we must admit that, with slight exceptions, these sheets carry out in an unexceptionable way the rules laid down by the Committee. But the whole point of my remarks this afternoon has been that the rules must not be so treated. They were not made by the Medes and the Persians, but by a committee of scientific map-makers, who will be the first to admit that in these matters you cannot tell till you try, and that no *a priori* scheme can pass altogether unscathed through the test of experience.

If we grant that the scheme is still open to amendment, then I would urge that now is the time to discuss and to experiment. The subject of colour-printed maps is a fascinating one. It is still very young, and it has before it a brilliant future. I shall be happy if these remarks, prompted by an enthusiasm for the subject, but unfettered, as you will have seen, by any precise appreciation of the difficulties of technique, perhaps suggest to more competent cartographers one or two directions in which experiment would be interesting, and I believe fruitful.

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THE DIARY OF TWO NOVICES IN NYASALAND.

(*Continued*).

By Lieut. J. Benskin, R.E.

Tuesday, 13th September.—Fish's foot was so bad that he stayed in camp and nursed his blisters. There was a thick white mist when we left at 5.30, so we walked in a straight line hoping to pick up fresh spoor and within a mile of camp found fresh traces of wildebeest. Luckily the air soon cleared, and we found ourselves right on top of a herd of hartebeest and wildebeest. After a good long stalk I knocked over a fair-sized wildebeest bull, and then got carried away by the desire to hit, buck fever they call it, and twice wounded another one on the move. Ndala, the hunter, promptly gave chase and all my shouts to make the idiot stop only made him run the harder so that he kept the animal, which was wanting to lie down, on the move for half an hour. When I did get up to the gnu and could again fire and finish it off I found that much to my disgust I had killed a cow. In the far distance there were some sable, and I got a good-sized bull just under 40 in. along the horns, which is quite fair for Nyasaland. A little way further on I came upon a most amazing collection of spurwing geese, sitting out on the open dambo. There must have been over a thousand of them, and as I approached they got up in fifties together, 200 yards off, and flew towards Lake Chiuta to the north.

Zebra also were visible, and John and I were just beginning to follow when we saw far away and faintly visible through the quivering mirage of heat haze a solid clump of 40 to 50 herd of game. White tick birds were hovering above the herd, and on looking at them through the glasses they proved to be buffalo. John agreed with me, so a chit was written with a bullet as pencil, and I sent off Simbota to make Fish come out at once. The buffalo were slowly approaching us and drove John and myself back about a mile before Fish arrived in an improvised machila. There was hardly any cover, just one belt of long grass up to which we hoped to get and there wait for the herd which might approach. It took us quite a quarter of an hour to reach, creeping over most painful grass stumps and swallowing huge mouthfuls of black ashes. The herd was behind the long grass and we could not see them. At last we reached the clump and cautiously pushed aside some grass to see out the other side, and there we saw,

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still leisurely grazing, not a mighty herd of buffalo but a herd of wildebeest with a few sable. The heat haze had deceived us. Fish was so upset that when he fired at one of the sable he only managed to wound it, failed to get it in the end and went home disgusted in his machila; I was luckier, for on the way back I finished my day by killing quite a nice reedbuck, rather a brutal act as the cow with two youngsters were standing by.

When we reached camp we found our small island covered with about 50 women and children from a village 10 miles off, who were making a terrible noise and bathing in our water, so we packed the whole lot off straight away whilst they moaned about lions and the dangers of the night.

Wednesday, 14th September.—Having had a bad night I sauntered about camp—trying to snipe marabou, without success, in the morning—and in the evening watched some wildebeest and reedbuck from less than 100 yards off. A big pau squatted 20 yards off me, but I did not shoot at anything as all the beasts were nice to see.

Fish was feeling jealous of me so he went off at 4.30, and the early rise so upset his nerve that he did nothing but wound animals all day, although he is really an exceptionally good shot. He hit a hartebeest, a sable and a bull buffalo, all of which he followed till he lost the spoor; but he finally brought back a wildebeest.

John seemed to have played much the same tricks with Fish as he had with me, ran him off his legs to within 15 yards of the beasts, when the one big bull was hit, and then went crazy, imagined he was a cattle drover and rushed shrieking at the herd trying to drive it on to Fish. It was very bad luck not getting any of the wounded creatures, but only to be expected if Fish would play such unexpected tricks with his constitution.

Thursday, 15th September.—After his previous day's work Fish made up for lost time and slept until 11, went out and got a good sable. I unsuccessfully tried to find and claim some of his wounded animals, and killed a sable cow.

There was a big grass fire burning close to camp and it was great fun watching all the birds of prey squatting on the edge of it catching small creatures as they came out. A lucky shot of mine killed two marabou with one bullet, which made my reputation as a marksman, and the boys would trust me anywhere after that.

Friday, 16th September.—Nabwasi was beginning to become tedious and so very unhealthy that we moved on to another tiny island of rock and trees, named Nafisi, 5 miles off. On the way we crossed quite fresh spoor of buffalo. Luckily John was with the Tenga-Tenga so we felt comparatively safe and followed it up into some longish grass. For half an hour we meandered about in it trying to locate the creatures, until the tick birds were seen and we at last saw the two bulls' backs in a place where the grass might have been

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worse. It was Fish's shot, so he took a steady aim, tried to press the trigger and nearly broke something until he grasped the fact that his rifle was at safe. Meanwhile the bulls wandered away into cover. This time we did not need John to lead us on to glory, we both dashed after the creatures and Fish just knocked one over with a shot which I followed up with another hit. The bull got up and was again in cover, nasty unsafe thick grass this time, whilst his pal vanished the other way. I have never known Fish to be so courteous and unselfish as he became on that occasion. "It's your beast, old man. You hit first. Go on and finish it. You have all the luck," said he and turned to go home. But I knew my duty and replied "No, Fish, you cannot fail to recollect that the Acting Governor only gave us permission to slay one bull buffalo apiece. Much as I appreciate your kindly thought, I must refuse, and can only most reluctantly remind you that you would be doing me an unkindness were you not to claim that wounded buffalo. I might be arrested if I shot it." He had to go in, and with one clean shot killed it as it rose to go for him. He was a very fine bull, of greater spread than mine, but fairly young and the palm in front was comparatively small. Whilst tying the knot in his tail and cutting him up we suddenly heard a rustle in the grass quite close and found his mate returning to find out what had happened; so we stood on guard and were not again disturbed.

All this had taken time and although Nafisi was only 5 miles off we had to tramp through the heat of midday, for the most of the way through 18 in. of swamp where we saw several egrets. Nafisi turned out to be so infested with mosquitoes that we decided to move on again the next morning.

Saturday, 17th September.—Ndala had been left at Nabwasi in charge of the heads with orders to follow on. All of his friends who had joined us from Mtalala as bearers had already deserted, having eaten enough to last for a month, and we were so anxious about him that we never made a start until we saw his movements across the plain.

Chipolonga was to be the next camp—the open dambo was to be quitted and we were to again try our hands at shooting in the bush. Simbota tried to lead Fish and myself, and after walking 6 miles into the bush politely admitted that he had no idea where Chipolonga and he himself were situated. Camp was discovered late in the evening, when we had walked 18 miles, and it was an unfortunate moment for Ndala to have appeared begging for a presenti. He had been useless as a hunter, and the centre of constant trouble, so he was dismissed on the spot and never seen again.

Sunday, 18th September.—Chipolonga was about 5 miles to the west of Lake Chiuta, and not far from Mount Chegomani. The village was one of a long straggling native settlement, whose chief

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had appeared in search of presentis, and in return for them the information that Lake Chiuta could be crossed dry foot by walking on the backs of the ducks and geese. We hardly believed the latter part of the tale, but were glad when promised two guides who would lead us to a spot quite "pafupi" where two canoes could be obtained and which at least suggested water. Having bicycled 7 miles we reached a bleak stretch of water at the edge of which our guides sat down beside some onlookers, said nothing and waited. Assuming that something was going to happen we also waited. Presently we asked "Is this the place?" "Indeo! yes indeed!" "Where are the canoes?" "They have gone." "Where are the duck?" "They have gone." "When were you last here?" "Three months ago?" And four months ago a fisherman, since dead, had owned a canoe and some duck had been seen. The episode was merely representative of the natives' minds and their determination to give immediate pleasure at any cost. We were learning.

We silently reached our tents just as it began to rain—the first shower that we had had—and pondered over the immorality of shooting on Sundays.

Monday, 19th September.—Eighteen miles ahead we arrived at Nyanezi, a charmingly pretty spot, with a waterfall and great overhanging trees and ferns. The road had been only about 2 ft. wide and very bad in places, so we had runners ahead of us to give warning and carry the jingas if too bad. Expert as we were becoming at taking headers over tree stumps and at wild plunges into the jungle we found that we could not keep up with the boys. There was nothing to shoot and we only saw old eland and kudu spoor.

Tuesday, 20th September.—A 20-mile journey towards Fort Mangoche, starting at 6 punctually, brought us at 12.30 to Cheanombu. Our guides led us in circles through the hills and showed the usual native inability to go straight to the point. The camp was close to running water and at the foot of the Fort Mangoche Hill. At 3 o'clock we visited a Swiss White Father or rather Farmer with a big estate—and were most cordially received by him and given invaluable information. He knew the Portuguese country, the boundary of which was only 4 miles off, as well as any man living and stoutly maintained that the land was not worth a visit.

Staying with him was a German professional hunter who had just spent two months in that very district, and who now found himself landed up country without a penny in the world. Apparently he had allowed himself to be beguiled by that very same individual who had nearly attracted us on first arrival at Chinde. The tales of countless elephant had proved too much, and the trickster had been allowed to take the German for some exorbitant fee in his boat from Fort Johnston, and to use that local knowledge which alone could produce a Portuguese licence. When under way he had found out

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that his licence was only available for one small 10-mile square plot of the many Portuguese districts, and during the whole two months he had never seen an elephant spoor. We had indeed been lucky, and promptly decided to make for Fort Maguire where we knew that elephant could be found.

Wednesday, 21st September.—Twenty-two miles along an excellent but hilly road to Natchiwali, just south of Uzuzu Hill and on the way to Malindi, proved rather trying for our boys who gave trouble on arrival. After a bit of palaver they tumbled to good manners, and by then we knew how to treat them. We came to the conclusion that every native is rather a snob. They seemed to notice every little action and always knew if a man were a gentleman or not, but would, I think, have been inclined to overvalue money. To have punished a boy violently would have been a great mistake. John innocently gave us a tip for behaviour one day by referring to us as being great visitors in comparison to the boma people who lived in the country; so we acted on the line of treating the law as our servant who would punish if necessary, and in addition always tried to be if possible humorous. The fact that we were soldiers carried much weight.

Thursday, 22nd September.—"Lake Nyasa, I presume," said Fish on first seeing the stretch of water 10 miles ahead of us and in recollection of the great missionary who had lived and died at the foot of the mountains down which we were climbing. The scene was beautiful and perhaps improved by the difficulty one had in finding any place sufficiently clear of trees to let one have an entirely uninterrupted view. Monkey Bay, with its background of downy mountains, could be seen across the blue water, and all to the south and at the foot of the steep hills lay the flat plain, a light green carpet of trees sweltering with heat and only broken by the Shire River flowing through Fort Johnston and ultimately on to the Zambezi and the sea. It was too steep to bicycle so the jingas were packed on to the boys' heads and we jogged down hill to a village named Malindi, where we found ourselves confronted by a modern gothic church and a comfortable-looking stone house owned by the Universities Mission. Lunch with the architect of the church proved most interesting, as Mr. George was also architect of that world's wonder, the cathedral on Likoma Island. Considering that every bit of the work had been done by natives trained by the mission, the result was extraordinary. Decoration had not been forgotten and the church had a handsome reredos and pulpit, carved in correct religious fashion in wood and soapstone.

The road along the edge of the lake was excellent, 10 ft. wide and on hard ground, some 300 to 400 yards clear of the sand which the natives had chosen for their villages. Eighteen miles were covered that day to Pitakalanji where Fish killed quite a nice

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bush buck. The road was too closely packed with villages for one to hope to be able to get much sport along that shore, and I only saw a few small buck running away in the bush.

Friday, 23rd September.—At Pitakalanji we varied our amusements by taking two native dug-out canoes and having a try after a mixed bag of hippo, crocodiles, pelicans and duck. A dug-out is at best an unstable vessel, and when the wind rose it became quite impossible to take a steady aim with a rifle, so we concentrated our fire on the birds alone. They were far too wary; every villager had a bow and arrow and the birds scattered at sight of the canoes. The lake was very shallow and clear and one could see countless good-sized fish in the water as we were poled along.

Away out on the horizon there were some white rocks, which the boys said were always covered with duck and geese so we went for them. On getting close the white covering turned out to be a solid mass of many hundred pelican with a few flamingoes, which waddled into the water as we approached and paddled away quietly for 100 yards. There were several hippo quite close and we had great fun watching them. My boat was heavier than Fish's, and the boys ran me on to a sand bank across which we must have pushed the canoe for half an hour. They were such idiots in their attempts to push in different directions that I had to get out and do the work myself, whilst Fish, who was comfortably floating, jeered at me and as usual took photographs whenever he thought I was at a disadvantage.

We also were fools that day, for we bicycled from 12.30 to 3.15 in the heat of the day and nearly collapsed on reaching Saidi Mwazungu. The road became very bad and sandy, and on reaching camp we found the tents not up and trouble with the boys again taking place.

Fish was beginning to pride himself by then upon his knowledge of the Chinyanja language and he had a most charming manner of addressing natives with a flow of words which to the uninitiated sounded exactly like the correct phraseology. For my part I only really knew two words—"choka" and "iai," (pronounced eeii) and equivalent to the South African Footsack and Ikona. A wealth of meaning could be put into both words. But Fish would open the book of the language and commence "Njiri ya ku Saidi Mwazungu iri kuti?" in quite correct fashion "Which is the way to Saidi Mwazungu?" As he usually chose one of the half-witted women for his questions the answer was certain to be "Eeiiiii." That made him nervous and he would miss his place in the book "Kodi muli nazo nthiti zingati?" "How many ribs have you got?" And the woman also began to look nervous. And then began that extraordinary flow of meaningless sounds "Pafube mkazi chipolopolo siyanara patari" and finally as the woman was tearing away for her life, some good round English oaths ending up with "choka!" "Clear out!"

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Saturday, 24th September.—We held orderly room before moving, and were wondering how we ought to deal with the offenders of the previous day when John informed us that a resident happened to be collecting hut tax near by, so we remanded the accused and ran them in before the proper authority. The resident was varying his duties by killing a hippo as he wanted some hide, but he immediately postponed that excitement and most courteously told off our boys, assuring us that he knew that we would not again be troubled by them. On the whole the boys had been behaving fairly well. James and George had greatly improved, and were far pleasanter now as body servants than they had been at Nabwasi when there had been so much meat about. They stole the usual amount of sugar and jam but we had never lost anything else, and when George entreated me to show my complete confidence in him by letting him carry my pocket knife with the screw driver and button hook in it, I agreed, and gave him also my keys of the tin bockus and the store case which was in daily use, thus putting my final trust in him in the conventional manner of the country. The store box was padlocked one side, but off its hinges on the other so it did not make much difference what was done, yet the boys would always religiously make sure that it was securely locked.

Likoloma—17 miles ahead—was the next camp. In the afternoon we looked for game and I watched a herd of water buck cows quite close to me for some time. They have coarse meat and were therefore spared. Fish came upon kudu and lion spoor but saw nothing living. We had been having grass fires as a protection round our camps at night for some time and so felt fairly secure, particularly as between our tents and the ring of fires lay the boys. Even if the lions had not troubled us the boys had heard them often, and the hyenas had to be kept off our skins and heads. Most of the Nyasaland lions along that shore are too wary to make a noise, and take their victims silently.

John brought us news that he had heard that elephant were at Chelinda for certain, and that we could not fail to find them in the "Forest" as he termed it further north. By forest he meant a bush so thick with small trees that we would have difficulty in getting between them, and not one's accustomed idea of great trees laden with creepers.

Sunday, 25th September.—Just as we were leaving the camp near Likoloma a boy came in to give us ominous news. Whilst we had been safely sleeping inside our ring of fires, the village which was hardly 800 yards off had been visited by lions. Three lionesses and one lion had first killed a woman, and after being driven off by the boys had returned to make a raid on a goat house. The shelter was of the usual native pattern, with double walls 2 ft. apart and a floor raised 18 in. above the ground. The walls and floor and entrance

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were all built of stout poles but the roof was only thatched and the whole structure much resembled a native kraal. The lions had forced a hole through the top, killed two goats, mauled several and only gone off with one.

All the villages along that strip of the lake are built on the sand just clear of the thick reeds at the water's edge, and, as a strong wind was blowing, such faint spoor marks as we could see at first were soon obliterated. In one respect this was rather comforting as the tracks had led us to a patch of banyan trees and weeds which was so thick that we could only get through on all fours, and side by side with shot guns loaded with buck shot at the ready. Apparently these lions were famous man-eaters and had a regular beat along that part of the lake, and whenever hungry used to levy their certain toll on each village in succession. Usually they visited the same village for three consecutive nights, so we decided to build ourselves machans above the goat house to tie up a kid and to try our luck. There were two shelters but only one had been broken into ; two rickety platforms were built of poles and leaves above them, and Fish proved lucky in drawing lots for the goat house with the hole. The rest of the day was spent doctoring one or two sickly-looking children and in leisurely paddling about the lake in a dug-out from which long shots were taken at the wily crocs and geese with our rifles.

At 7.30 in the evening we climbed up to our perches, shouted out good night to John and Simbota and began our long watch. The shelters were right on the edge of the scattered village, and mine had one side even touching a house which I knew to be packed with villagers yet never once did I hear a single sound come up from the poor scared niggers. It was a pitch black night and one could hardly see the kid who kept up an incessant bleat every few minutes. An hour must have passed when all at once a terrific hullabaloo and kicking and scraping commenced in Fish's shelter. Evidently the lions were already inside the goat house, but after 10 minutes or so of the clamour there was again quiet, save for a few angry oaths that fell from the tree and satisfied me that the speaker had not himself fallen down.

Nothing seemed to happen at my end of the village until a long lean cat or serval darted out from the grass and spat at the poor little kid till the bleat was stifled to a weak moan of terror. Then the moon came out and I saw a huge black mass plunge through some mealies 30 yards away—a hippo running inland to find some food. And the sameness of the silent watch must have made me doze for I suddenly to my horror noticed that my goat had gone, stealthily seized no doubt by one of the lions. But a long-drawn bleat was once more heard, this time from behind the shelter, and presently the kid could be seen running around and trying to find a way inside to its mother. Then came a heart-burning problem to my mind.

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Should I climb down from my safe tree to chase that goat and tie it up again, and in doing so probably scare away the lions, who should by all rights have been 100 yards away thinking about the goat, and possibly about my own valuable body—or should I unselfishly give up all further hope of having a shot, leave all the glory to Fish and reluctantly sleep as much as one could in such a nest. The goat settled the anxious question for me; by dint of much kicking and scratching he managed to force a way to between the double walls of his home where he sensibly went to sleep.

I rather believe that Fish lived up to his reputation and did the same. The only adventure that he had to tell of during the night had been the cause of all that uproar. John and Simbota had felt insulted on being sent to bed, so John had stolen Fish's little gun and Simbota my hunting knife and those two tigers had stealthily moved the door and crawled into the goat kraal—hence all the uproar and disgust on the part of the goats—and had endeavoured to sit down in that dark place and wait for the four lions to come through the small hole 5 ft. above their heads, when they intended to kill them one by one as they came in.

Monday, 26th September.—After our sleepless night we were not fit for much. Chelinda 8 miles ahead was soon reached on our jingas, and whilst waiting for the Tenga-Tenga we lay out under a tree and slept soundly. The boys of Chelinda gave us splendid news and said that elephant were always close to their village and that some were even then only about 6 miles off. Up to date it had always been hard to realize that we had ever left the comforts of home at all, although of course we merely took our civilization with us; and elephant alone of all the beasts of Africa seemed to suggest that one would be really away from the haunts of white men.

It needed some cruel tale of death, such as the slaughter of that woman by the lions, to strikingly bring home to one the grim undercurrent of reality that exists in Africa, and this was doubly brought home by the natives of Likoloma. When lazily shooting at the crocodiles the day before, the villagers had asked me to above all kill one very large beast for whom they had a particular dislike. I had one shot, and missed, and did not try again as he sank leaving no more than two eyeballs as a target. A long lean Swahili boy had asked to come with us from the village as he had hunted elephant in his time, but when he arrived at Chelinda he was hurriedly summoned to return because his sister had just been eaten by the very same big crocodile that I had missed.

Tuesday, 27th September.—At last we were going to start after elephant. John and the two gun-bearers went with us, two Tenga-Tenga carried water and food whilst three boys from Chelinda village came forward as guides. One of the latter, a fine old fellow with a little grizzled beard and who carried a short stabbing spear made of

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a single piece of metal, promised to be invaluable, for he quietly stated that he had been one of the trackers for an elephant hunter whose fame is world renowned.

We were clear of camp by five in the morning and by 8 o'clock had reached the thick "forest" where the elephants had been the previous day, and there for the first time saw the huge footprints of the creatures. The tracks were for the most part ancient, and dated from the previous season's wet weather, great holes 9 in. deep where every step had sunk into soft ground. But the old man soon picked up the new spoor and out of a confused jumble of marks determined the direction which the elephants had taken. The herd had consisted of about 15 animals, of cows and young ones, and with one big bull. They seemed to have been quietly moving northwards to the edge of the forest, and then much to our grief we found they had formed into the single file formation which denoted a deliberate trek to some other grounds.

Anyhow we followed them, and with our first experience of following elephant we realized that it was not to be all amusement. For four and a-half hours we silently trudged after the huge footprints. The heat was intense, and the ground amazing hard, so much so that at times the spoor was entirely lost to our European eyes. One hardly expected that 15 elephant could leave no trace of their movements behind them, but such seemed to be the usual case, until on reaching some patch where the grass had been recently burnt one could again see where every step had been taken and the boys would begin to speculate on the number and size of the herd. There was no question as to our having reached the certain home of the animals for every few yards one could see the signs of their work such as broken tree branches or remnants of their dung, and often the faint traces of the new spoor became lost in the many old tracks and marks, some of which were only a few days old. And so we went on remembering the advice given us to never talk out loud and always to be ready to come upon them at any moment. The wind was favourable with the slightest puff in our faces—and in the breast pockets of our shirts we had a little English flour to tap and so find out if needs be how it blew.

It was nice country with clumps of low bushes at the foot of euphorbias or strange trees, with stranger seed pods hanging from them, scattered about 30 yards apart and never thick except when bordering some dried-up sandy-bottomed nullah. In the shade of one of these we halted for lunch, well-nigh exhausted by that oppressive heat which hitherto we had always avoided by a midday siesta.

After half-an-hour's rest we rose, whereupon Fish commenced to grumble and talk at the top of his voice, and so began our first sincere quarrel. It was one thing to grouse—I had been doing so in a

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despairing murmur for the last two hours myself—but if there was anything to be believed in what the books said it would be quite useless to both spoor, and at the same time chatter out loud some silly desires as to the elephant being a couple of hundred yards away. Even the old man with a spear looked pained, the boys patiently waited until we had finished our estimates of each other's characters and we were again ready to push on up wind and through the thick bush along one edge of the twisting nullah, when we suddenly and quite distinctly heard some crashes of broken trees not 100 yards off and found ourselves sniffing the air at a heavy smell which had last been smelt in the Zoo at home. With a silent bound Simbota and Kokwana were pressing the big guns into our hands, John's face began to twist and quiver with savage excitement; the Tenga-Tenga and villagers vanished, and the old man alone completely calm began to quietly lead the way.

It was a very thick spot with long unburnt grass which we crept through to the lesser cover of bushes and trees at the donga's edge. And here the old man stopped, with one whisper of "Njobvu" (elephant) and with the satisfied assurance of the man who has done his work he pointed across the water bed and stepped behind us. The donga was barely 20 yards across, with the far bank fringed by the same big trees, and in vain we peered into them trying to distinguish some form which could account for that rustle of slow movements, until there was another rending crash and a big branch was seen to be slowly forced down and gradually a long grey trunk, with behind it a great flat ear, took shape high up amongst the leaves, and the outline became confirmed by the white glimmer of ivory.

Presently other grey forms were indistinctly seen, then a baby elephant walked into an open patch and was joined by her mother, and both went back to the shade of the trees. The whole herd must have been within 35 yards of us, and yet personally I never saw more than five at any one time. John who was kneeling alongside us said that he could count eighteen. At first his usual desire to get Nyama of any kind had got the better of him and he had entreated us to shoot at everything and anything, but we knew better than that, and for fully 10 minutes we tried to distinguish a bull of size worth aiming at. There was one smallish fellow, with ivory which could only have been of about 15 lbs. weight, whom we spared, and all the other tusks which momentarily appeared through the leaves showed the long thin points of cows. The herd seemed to be gently strolling around in the shadow of the big trees, keeping up a continual steady swing of those great ears which would often be the only visible part of their bodies. At last the huge shape of the one big bull, whose spoor we had followed, slowly pushed to one side, and to our bitter disappointment we saw he was without ivory.

After watching the herd for another five minutes every second of

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which was thrilling although probably safe, for an elephant is very blind and comparatively deaf, we were preparing to crawl away when a wretched little fly flew into my eye and utterly blinded me. Finally Fish's assistance had to be obtained to get it out, and in the end we both boldly stood up behind a tree and he set to work extracting it. But before doing so he whispered "Hold my gun for me." "Is it at safe?" said I. "No! and I shan't put it at safe either with those beasts still talking over there," and we again began to squabble. So I bent down to put it at safe and with a deafening explosion the 470 went off and a bullet which must have passed within an inch of both our heads went speeding into the sky. It was one of the most terrifying moments of our lives; each of us thought himself and the other dead, the elephants who had promptly bolted the other way were forgotten, John shrugged his shoulders with scorn, and until late that night when safe in bed (near a village named Kachepa) our ears were still ringing with that horrible noise, and our tongues wagging with mutual recriminations about a first shot at an elephant—recriminations which for my part were doubly vehement at the thought of how close I had been to killing my friend. Let novices take heed!

Wednesday, 28th September.—Kachepa was only about 10 miles north-west from Chelinda, and about a mile north of the main hoe road to Fort Maguire. All south of that road and right up to the lake's edge the bush was intensely thick, a close mass of slender leafless trees about 4 in. in diameter, but scattered about at every hundred yards or so apart one found a baobab whose cream-of-tartar fruit attracted the elephants when they stood resting from the midday sun.

By 5 o'clock we were again out in the direction of the lake hoping to cut across some spoor, and by 6.30 came upon the tracks of two good bulls, both worth following too, for the spoor when measured across with one's forearm reached from the point of the elbow to the tip of the third finger.

Until midday we trudged on, twisting round and under the little shadeless branches which the bulls had merely brushed aside, until again we heard the sounds of their movements, some distance off. But this time when just approaching our prey we stepped into a regular jumble of quite fresh spoor and almost simultaneously found ourselves on top of a herd. In order to see at all it was necessary to get most unpleasantly close; then as on the previous day we had the same long gaze through branches, and when at last we did locate the individual shadowy creatures it was only to have another most sickening disappointment. There stood the same old tuskless bull towering high above us, and we realized that the same useless herd which we had scared yesterday were again in front and dividing us from our proper target.

There was not much point in staying there for long, in fact I doubt

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if anyone can feel really at perfect ease when only 30 yards of thin twigs separated one from a herd of those huge beasts, and when a cow suddenly gave a shrill scream of anger at one of her naughty children who was lying down, we quickly retreated. A detour to pick up the two bulls' spoor proved useless and we crawled back under the cruel sun to the comfort of our tents.

Thursday, 29th September.—John came to give us important news when we had finished our early breakfast. Our despondency at not having already killed an elephant in our first two days' chase after them had touched his gentle heart, so he wished to reassure us by tales of good omen. During the night he had had two good dreams, dreams which he only dreamt when something wonderful was going to take place, and he wished to tell them to us. With the soft voice of any little lady talking in a drawing-room he let fall from his lips "Bwana. I dream I am a little child playing with the small stones on the shore of the lake. That is a good dream, and Bwana will get Njobvu to-day. But, Bwana, I dream my best dream also," and with a sudden change of expression which became quite ghastly in its savage intensity, "I dream I cut up man's stomach. Bwana will indeed get Njobvu to-day."

Thus enheartened we set out northwards and seemed to spend interminable hours walking in a great circle, ever hoping to find some tracks worth following. Once we found the spoor of some small bulls, not big enough to follow, and again found the quite new tracks of a herd of cows and young. Several times we came upon individual footprints of cows, and even upon the trail of some little lonely baby elephants whose parents must have been slaughtered by the Portuguese natives. We must have gone a good long way and perhaps over the borderland, for we twice heard some far-away sounds of shooting, which could only have been caused by a Portuguese native. These boys are all allowed to carry guns and keep up an endless and indiscriminate slaughter of everything they can see, so much so that the small triangle of British country round Fort Maguire was a veritable sanctuary for the poor harassed creatures.

By 1 o'clock we were back in camp telling John that we did not think much of his dreams which he had better try to improve upon. Our village was a very poor specimen indeed of a native home, with water which we were perhaps foolish to risk drinking. However, the great attraction of that Fort Maguire district lay in the good food which we could get, whilst at the same time chasing elephant. Fresh fish from the lake and fresh eggs and vegetables, such as paw paw, sweet potatoes, bananas and fresh mealies, could always be sent for from Likoloma, and we were actually able to get fresh milk from a native who lived near Chelinda and who called himself a missionary because he owned one cow. As usual the skinny nkuku formed the staple substance of the meal.

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Friday, 30th September.—Until 2 o'clock we again exhausted ourselves making a wide circle in the Fort Maguire direction, and practically repeating our previous day's efforts. One incident relieved the monotony, but monotony is a harsh word to use, as for my part I never felt dull when forcing my way through that bush. There was always something of unusual interest in the form of plants or insects to be seen, and one used to make the boys bring in anything which they thought would prove out of the common. Thus one learnt the foods of the elephant, and which seed pods could be eaten as fruit or as medicine, and a mass of little information easily forgotten when wearily trudging along.

We were suddenly stopped dead by hearing quite close to us in the bush the deep-toned reverberating grunts of two lions—"noising" as John termed it. Without a word the porters shinned up the silly little trees which bent to the ground under their weights, and the old man with the spear sidled up to join us in the fun. The wind was right, and the lions apparently unscared as they kept up their "noising" in a way which made us all think that they must for certain be upon a kill, especially as we presently heard the sharper grunts of an interfering leopard hovering around them. Very carefully and quietly we crept through the brushwood until we were within 40 yards of a big baobab, behind which the noise continued. As usual the close-packed cluster of slender stems made all view impossible, and dead leaves from the baobab must have made our movements audible for the grunting ceased and when next heard it was some hundred yards further on where it would have been waste of time to follow. There was no kill under the tree and our boys were probably right when they said that the lions were making love.

The indefatigable old man so intent upon producing us elephant to kill continued out all day, and late in the evening returned to camp with the news that he had again found the fresh spoor of those two big bulls.

(*To be concluded*).

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AN ENGINEER OFFICER UNDER WELLINGTON IN THE PENINSULA.

(*Continued*).

(*Edited by* COMMANDER THE HON. HENRY N. SHORE, R.N., RETIRED).

Reverting to the Diary :—*April* 21, 1811. Lord Wellington and Col. Fletcher reconnoitred Badajoz.

April 24. Lord Wellington went back to Almeida. The Guadiana rose this night 7 ft. perpendicular, and carried away the bridge of boats at Jerumenha.

NOTE.—Napier tells us that, on the 24th, Wellington had forded the Guadiana, and pushing close up to Badajoz with a force of cavalry and infantry, endeavoured to cut off a convoy going to the place ; but the alert governor sallied, and the allies lost a hundred men without stopping the convoy.

Lord Wellington's sudden departure for the north again, was brought about by unexpected news that Massena was once more in motion. Meanwhile, preparations for the Siege of Badajoz were pushed forward. The Diary records the restoration of the bridge over the Guadiana on the 29th April ; the preparation of platforms, in the Arsenal at Elvas; the Artificers being practised at Sapping; and every exertion being made to procure cars.

The following observations by Napier with reference to the approaching siege are here quoted, as especially worthy of attention :— "This was the first serious siege undertaken by the British in the Peninsula, and to the discredit of the English Government, no army was ever worse provided for such an enterprise. Without a corps of sappers and miners, they were compelled to attack fortresses defended by the most warlike, practised, and scientific troops of the age ; and the best officers and the finest soldiers sacrificed themselves in a lamentable manner to compensate for the negligence and incapacity of government. The sieges carried on by the British in Spain were a succession of butcheries, because the commonest materials and means necessary for their work were denied to the engineers."

We will now return to the Diary, observing that the author acted as Adjutant of Engineers during the siege :—

Elvas, May 4, 1811. Extremely hot weather. Maj.-Gen. Hon. W. Stewart invested Badajoz on the other side of the Guadiana this morning, with 3 Brigades of Infantry and a few Portuguese cavalry. Col. Fletcher and Jones went to meet Gen. Stewart, but returned in

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the evening. The 3 large boats moved to the situation chosen, near the confluence of the Caya and Guardiana.

May 5. The enemy reconnoitred very near our new bridge ; Col. Fletcher, in consequence procured a battalion of the 17th Portuguese Regt. for its protection.

7th. Col. Fletcher moved to the camp before Badajoz. Capt. Squire and 2nd and 5th Brigades of Engineers left here to carry on the attack against Ft. Christoval. Lt. Forster reconnoitred to the foot of the old Castle wall.

ELVAS, *May* 7, 1811.

MY DEAR FATHER,

. . . For my own part I never felt better in my life. Lord Wellington made a sudden move the day after I wrote to you from Villa Formosa, and Col. Fletcher, and B.-Major Jones and myself came here at the same time. His Lordship remained here a few days only, during which he reconnoitred Badajos, and determined upon undertaking the siege, and then returned towards Almeida, leaving us here to carry it on. Badajos was invested on the sides, on the left of the river Guadiana on the 4th Inst. but by some means (to us unaccountable) not a man have we between this town and Badajos, or on the right bank of the river. If the investment is completed to-night, as I fully expect it will, we shall in all probability break ground to-morrow night. Col. Fletcher went from hence to our camp before Badajos this morning ; I have some of his arrangements to see executed, and rejoin him in the course of to-morrow.

It is now very late, you must therefore excuse the brevity of this epistle. . . . We have 21 officers of the Engineers here altogether. I am quite delighted at the prospect of witnessing the operations of a siege such as this is likely to be. . . .

Your very loving son,
RICE JONES.

8th. Maj.-Gen. Lumley appeared before Ft. Christoval about 8 o'clock and completed the investment of Badajoz, with the loss of near 200 men. Capt. Squire broke ground this night before Ft. Christoval, at 450 yds. ; the soil proved rocky, and the enemy opened a heavy fire as soon as they began. The 1st Brigade broke ground before the Picourinho with 800 men ; and the 3rd on a false attack against Ft. Pardilleros.

May 9th. Having sent all our stores from Elvas, I moved to the depôt before Badajoz ; found our Brig.-Maj. had arranged everything for breaking ground before the body of the place at night. At 5 p.m., Col. Fletcher returned to the depôt (having been all day with Sir W. Beresford on the other side of the river) and countermanded all the arrangements ; the Marshal having forbidden our proceeding this night. The party at work before St. Christoval were employed during the day in raising the Battery and obtaining cover for the guards. The enemy kept up a heavy fire of guns, mortars and musketry upon them, and their casualties were great. Capt. Ross

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and Boteler and Lt. Melville were wounded. The attacks against the Padrillera and Picourinho continued, and the enemy fired upon them occasionally, but without effect. At night the parties were employed in completing the batteries and parallels against the Picourinho and Padrillera. Capt. Squire's Brigades continued their work against St. Christoval, yet raised the battery but little from the extreme hardness of the soil, and the interruption given by the fire of the enemy.

Friday, May 10. The battery against the Picourinho completed and the guns mounted before 9 o'clock this morning. The parties continued raising the battery against St. Christoval. About 7 a.m., the enemy made a sortie with not less than 1,000 men and gained possession of the work for about a minute or two; when they were driven back by the covering party. Lt. Reid, the engineer on duty, was slightly wounded, and distinguished himself by rallying the troops. Nominal reliefs sent to the false attack and that on the Picourinho; the enemy fired occasionally, but did no harm on this side, but against the St. Christoval attack it was very heavy. Marshal Beresford still forbidding our proceeding with the attack against the body of the place, 200 yds. more of the parallel against the Picourinho was opened, and an approach of 250 yds. against the Padrillera was traced out and opened this evening in order to amuse the enemy on this side. The Battery against San Christoval was completed and the guns mounted, notwithstanding the heavy fire upon it. A Battery of 4 guns to enfilade the Bridge and prevent sorties, commenced this evening. Lt. Melville was killed by a cannon shot in the Battery against San Christoval at sunset. Marshal Beresford having given permission to commence operations against the place to-morrow evening, several car loads of stores were removed to the depôt near the Talavera road, during the night.

May 11. Soon after 2 a.m., set out to mark the directions of the intended attack, but was prevented in this by a thick fog at daylight; small parties were employed at the false attack, and at the attack against the Picourinho; the enemy showed some jealousy at the former and opened a fire upon it, but without effect. On the other side, the Battery to enfilade the bridge was much advanced. His country and the service sustained a severe loss in Capt. Dickinson whose head was carried off by a cannon shot, whilst standing on the parapet encouraging the workmen; in him I have lost a sincere and valued friend and brother-officer. He was interred with Melville in Capella de Carvalho.

The Battery against San Christoval opened at daylight this morning; the Portuguese Artillery directing the fire were inexperienced, and made very bad practice; whilst the enemy kept up a very hot fire, and completely silenced it before night. The guns were withdrawn and the embrasures masked in the night; another work was

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begun this evening against the enemy's battery in the castle, under cover of the hill, and on the left of that against San Christoval. The Battery against the Picourinha fired nearly 200 rounds this day, but produced not the smallest effect.. 1,400 men were ordered to parade at 6 o'clock, the tools arranged at the new depôt, and everything was ready to commence our attack at the body of the place, when at 5 p.m., Col. Fletcher received notice of the arrival of our stores at Elvas, the Portuguese tools being very bad, and it being of consequence to secure sufficient cover before daylight, it was judged expedient to defer the attack until next night, and a letter was sent to Marshal Beresford acquainting him with this determination. At 7 p.m., an order was received from the Marshal to suspend the work and the conveyance of stores across the river, for the present; orders were therefore sent to stop the stores from Lisbon, which Capt. By, and afterwards myself, were sent to Elvas to hurry on. I slept at Elvas this night.

Sunday, May 12. Returned from Elvas this morning. At one o'clock Sir W. Beresford consented to our breaking ground this night. The tools which had been sent back by the Marshal's order of last evening were immediately ordered up again; but it was ½ past 7 before they could be got to the ground where the working party (1,400 men) and the covering party (1,500) were paraded; and it was between 8 and 9 before they could be distributed. The weather which had hitherto been extremely fine became suddenly cloudy this afternoon, with rain, and the night was uncommonly dark and cloudy until 10 o'clock, when the moon rose and the weather became clear. The party were immediately set to work, and opened a parallel 800 yds. in length, at 600 yds. from the place, and an approach 600 yds. to the rear. The soil proved so very favourable and the men worked so well, being unperceived by the enemy, that the parallel was generally 3 ft., and 3 ft. 6 in. deep, by 4 ft. in width, and there was every prospect of being well covered before daylight, when, at 1 a.m. on the morning of the 13th, orders were received to withdraw the workmen from the trenches, and send the stores to the rear. The working and covering parties were then withdrawn, unperceived by the enemy, and all our means of transport employed to convey our stores over the Guadiana. Parties were employed during the night on the batteries against San Christoval; when the moon rose the enemy opened a fire upon the new lower battery.

May 13. All our cars employed in carrying away stores to the right bank of the Guadiana; the stores not worth carriage, or for which carriage could not be procured were ordered to be destroyed. Sent with this order to Capt. Squire at the camp before San Christoval; visited the batteries against that fort and returned by the ford near our new depôt. A pile of timber, fascines, and gabions were burnt there this night.

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May 14. At 6 a.m., Col. Fletcher ordered some of the stores crossing the Guadiana to be detained, and officers were sent in every direction to counter order the march of the stores to Elvas, in consequence of a communication from Sir W. Beresford of his uncertainty respecting the advance of the enemy. Shortly after, Capt. Rovena came and informed the Col. that General Cole had received an order to move the two Divisions of his army and raise the investment of the place. I was therefore sent to countermand the orders just given, and went on to Elvas to give the like directions to Mr. Davis. All our stores were over the river this evening. As soon as it became dark all our batteries were dismantled, and the platforms taken up and sent to the right bank of the river.

May 15. Showery weather. The flying bridge taken up and sent to Jurumenha, as were the officers and the artificers. The Marshal wrote to Col. Fletcher recommending him to secure the passages across the Guadiana during this rainy weather, as the ultimate safety of his army might depend upon it. The Col. in consequence, went to inspect them himself, and went this evening to Jurumenha, on his way to join the army. The enemy felt our pickets this morning to learn if the army had withdrawn from before the place, and succeeded in killing and wounding about 90 of our men in the evening. General Cole withdrew his Division at midnight, and finally raised the investment of the place; General Lumley having previously marched from before San Christoval. Attended Col. Fletcher to Jurumenha; arrived there after dark.

CAMP BEFORE BADAJOS, *May* 15, 1811.

MY DEAR FATHER,

A mail leaves this for England to-night, and though I have hardly a moment to spare, I cannot let it go without informing you of the disgraceful termination of our attack upon Badajos, and of my continued health and safety. The investment having been completed on the morning of the 8th Inst. batteries were that night commenced against Fort San Christoval, on the right bank of the river, opposite the town, and against two outworks on the south side . . . those upon the two latter being merely intended as a feint to draw the attention of the besieged to that side, whilst the real attack was to be upon the walls of an old castle which encloses Badajos on the north side, and have not the advantage of being covered by a ditch or covert way. Marshal Beresford was pressed to allow us to begin this our principal attack on the next night, (the 9th) in order that Marshal Soult might not be able to interrupt us before the fall of the place, and which the Colonel (Fletcher) calculated would take place in five days from the time we opened our first parallel; but it was not until the night of the 12th that the Marshal finally consented to our beginning; we however broke ground that night at between 5 and 600 yards from the walls, and had obtained tolerable good cover the whole length of our parallel (800 yards), when, at one o'clock on the morning of the 13th, an order arrived to stop everything, and during that day and

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yesterday all our artillery and stores were removed back into Elvas; nothing could have been going on better than we were when this order was received—occasioned, it is said, by a report of Marshal Soult being on his march towards this place. Marshal Beresford with his army (excepting a Division left to watch the Fortress, and they, I believe, will retire in the night) have marched; his Head Qrs. were to-day at Valverde, 4 leagues off.

. . . . . .

The attack upon Fort Christoval was continued all this time in the most determined manner by Capt. Squire. . . . The enemy also conducted their defence with great skill and spirit, and on the morning of the 10th made a sortie in considerable numbers, and succeeded in getting possession of our battery, but were speedily driven out of it again. . . . The officers of our Corps have suffered much; my worthy friend, Capt. Dickenson, and Lieut. Melville fell in the batteries. . . . I have not patience to write more on such a melancholy subject; hoping that justice awaits those who are guilty of all our loss and disgrace,

I remain yours,

RICE JONES.

P.S.—We go to-day to Marshal Beresford's Head Qrs., and if nothing goes on, shall, I imagine, return to Lord Wellington's army shortly.

NOTE.—For the better understanding of the recent operations, it is necessary to turn to Napier's remarks thereon :—

"At this time (May 11th) five engineers had fallen and 700 officers and soldiers of the line had been inscribed upon the bloody list of victims offered to this Moloch, and only one small battery against an outwork was completed. On the 11th it opened, and before sunset the fire of the enemy had disabled 4 of its 5 guns, and killed many more of the besiegers; nor could any other result be expected, because the concert essential to success in double operations, whether in sieges or the field was totally neglected by Beresford. Then, having received intelligence that the French Army was in movement, he arrested the progress of all the works. On the 12th, believing this information premature, he directed the trenches to be opened against the castle; yet the intelligence was true, and being confirmed at 12 o'clock at night, measures were taken to raise the siege."

The fact is, Soult had resolved to succour Badajoz. On the 14th he reached Villa Franca, and being then within 30 miles of Badajoz, fired salvoes during the night, to give notice of his approach to the garrison. Meanwhile, Beresford, after a conference with the Spanish generals, determined to meet the attack of the French Army at Albuera, which battle was fought the day after the siege was raised; viz., May 16.

Resuming the Diary :—

May 16. The morning was far advanced before Col. Fletcher and I left Jurumenha; passing near Olivenca, we heard of the action this morning; rode as hard as we could towards the scene; before we

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reached Valverde met a good many servants, Baggage, etc., going to the rear; as we approached the Field, some of the wounded, amongst others, General Cole. Joined Marshal Beresford and remained with the staff. Towards evening the Marshal and suite went into the village of Albuera, intending to dine there on what could be procured, but obliged to evacuate; though the Germans under General Alten did not give up possession of it. The enemy having the bridge could force them out when they liked. Lay on the field near the 34th Regt. Major Dickens affording us all the aid he could; rainy and uncomfortable all night; the ground being so very wet, and no shelter to be found.

May 17. Both armies occupied, all this day, the same ground as yesterday afternoon. During the night we slept under arms as before, but got a little refreshment from Col. Dickson.

May 18. At daybreak it appeared the enemy moved off last night. Rode on with the Spanish cavalry, in pursuit of them, until we came upon a body of their cavalry consisting of 25 Squadrons; when the Spaniards halted and the Conde de Penha Villamor sent me to inform Marshal Beresford whom I soon after met. Col. Fletcher, Jones and myself came here (Olivenca) upon our way back to Elvas, and procured good Qrs.

Elvas, Sunday, 19. Upon our arrival, found Lord Wellington just arrived from Almeida.

NOTE.—Napier tells us that Lord Wellington, after examining the state of affairs, directed the 3rd and 7th Divisions to complete the reinvestment of Badajoz on the right bank, and directed the renewed Siege of Badajoz in person. Resuming the Diary :—

Camp before Badajoz, May 29, 1811. Left Elvas about noon, after making all the necessary arrangements for the siege; found the stores in Depôt, and the troops bivouacing round Badajoz. *May 30th.* 300 men were employed last night at the false attack upon fort Pardeleras, and continued at it all this day. *May* 31. Soon after it became dusk last night, the parallel from the Talavera road, for 1,100 yds. towards the river, and the approach from the Parks began to be opened; two parties of 400 men each employed upon the former, and the same number upon the latter, which was about 1,000 yds. in length. The covering party consisted of 1,200, disposed in two large bodies before the centre of the parallel, with strong detachments upon each flank, and pickets and single Light Infantry pushed out in front. The enemy failed to discover the work before morning, when they opened a fire of six guns. At the San Christoval attack four batteries were commenced :—No. 1 of 5 guns against the Castle; No. 2 of 3 guns and 2 howitzers to breach the exposed flank of Fort San Christoval at 400 yds. dist.; No. 3 a battery of 4 guns to destroy the interior defences of the fort at 800 yds. dist.; No. 4 for 4 guns and 2 howitzers used as mortars, to

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enfilade the bridge and intercept the communications between the Fort and the Town. A parallel was also begun connecting the batteries; the working party employed consisted of 1,200 men; the covering party of 800. The enemy discovered their party and kept up a fire during the whole night.

NOTE.—From May 31st to the night of June 2nd the Diary gives full details of the number of men employed, and of the nature of their work. By the evening of June 2, "The batteries were all armed and furnished with ammunition."

June 3. At ½ past 9 this morning the batteries all opened; fired very inaccurately all day; but brought the old wall of the castle down before evening.

NOTE.—Full details of the siege works being given by Napier—and in greater detail by Sir John Jones, I pass on to the entry for June 6th :—*June 6th* to *7th*. At midnight the breach in the Flank of Fort San Christoval was assaulted without success. The advance of 25 men was led by Lieut. Forster who was mortally wounded at the close of the fight, which continued for more than an hour, with the greatest obstinacy on both sides. The foot of the breach said to have been cleared by the enemy to the height of 7 feet after it became dark in the evening.

After this failure, more guns were mounted, the fire resumed, and preparations completed for a renewed assault.

Sunday, June 9. At the end of this day's firing the rubbish in the castle breach was considerably increased; and the breach in the flank of San Christoval is again said to be practicable. At 9 this evening the party moved out of the works to assault Fort San Christoval, led by Lt. Hunt, who was killed on the glacis. The enemy being prepared gave them a sharp reception; the party consisting of 200, with an advance of 25, got into the ditch, where the Comdg. officer was killed. The attack continued about an hour, when the remains of the party, unable to force the breach, were recalled. The quantity of shells and combustibles thrown by the enemy into the ditch was enormous. We lost forty killed and 100 wounded.

June 10. At ten o'clock this morning a truce was obtained to bury our dead, during which I advanced to the French Picquet on the Rivellas to ascertain the fate of a Portuguese serjeant who was shot whilst accompanying me in reconnoitring the breach last night. In consequence of the movements of Marshals Soult and Marmont, and the deplorable state of our artillery, Lord Wellington, after the failure of last night's assault, determined to raise the siege.

June 12. The siege finally raised; the guns and stores being all retired. Our losses in the operations of the siege were 9 officers and 109 men killed and 25 officers and 350 men wounded and missing.

June 19. The French armies under Soult and Marmont having joined, entered Badajoz.

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CAMP BEFORE BADAJOS, *June* 12, 1811.

MY DEAR FATHER,

My last letter dated the 15th of May informed you of the chagrin we all felt at being obliged to raise the siege of Badajos; my present, I am sorry to say, has the like unfortunate news to communicate. After 12 days of open trenches, and 8 days battering, we have a second time sent our artillery and stores across the Guadiana to Elvas, and are now about to break up, and remove to that place ourselves. I have not time to send you a detail of our daily operations, and indeed it would be of but little use, as the newspapers will give it at greater length. However, I will just run over the dates of events as they happened since my last. The afternoon of that day we went from the camp to Jurumenha, for the purpose of inspecting the bridges across the Guadiana at that place, upon the security of which the safety of our army would entirely depend in the event of its meeting with a defeat. The next morning I proceeded with Col. Fletcher to join Marshal Beresford; upon the road we heard that his army was then engaged with that of Marshal Soult, and we of course pushed our horses to their utmost to get up in time; but before we could reach the field, the enemy were repulsed, and were quietly reposing on their own ground. I thus unfortunately missed the sanguinary battle of Albuera. We remained upon the ground that night, as well as the whole of the 17th in expectation of another attack; the whole French army being drawn out in front of us. During that night they began to retire, and the morning of the 18th found only their cavalry before us, which soon moved in compact order, being not less than 20 Squadrons, upon their principal routes. We then returned to Elvas on the 19th, and met Lord Wellington who with the 3rd and 7th Divisions had marched from Almeida after their repulse of Massena near that place. His Lordship immediately decided upon undertaking the siege of Badajos again, and upon the 29th of May we opened ground before Fort Paderillas, as a feint to draw the attention of the enemy to that quarter; the next night we began our approaches and parallel on the low ground before the old castle that I described to you before. . . . On the 10th it was determined to raise the siege, the reinforcements for Soult being at hand, and the old walls having proved so very hard and tough as to baffle all calculations as to the time when a practicable breach could be effected with the old, miserable Portuguese guns, which were nearly all disabled by our firing; and, added to our having expended nearly the whole of the shot and shells from Elvas, were I imagine the motives of this decision of his Lordship's.

We lost two very fine young men, Lts. Forster and Hunt, leading the storming parties to the assault; Capt. Patton was severely wounded, but I trust is doing well, and Capt. Mulcaster lies extremely ill from a fever brought on by excessive fatigue. I have met with several narrow escapes in common with the others, and have much reason to be thankful for having gone with safety through both sieges. . . .

Your very loving son,

RICE JONES.

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NOTE.—Here again failure was due to the inadequacy and inferior quality of the means available. The guns,—says Sir J. Jones, were of brass, false in their bore, and already worn by previous service ; and the shots were of all shapes and diameters, giving a windage from 1-10th to half an inch. The chambers of the howitzers used as mortars were all of unequal size, the shells did not fit the bore, and their beds were unsteady, so that the practice was vague and uncertain. The very tools,—says Napier, were unfit for work ; the French cutting instruments were eagerly sought for in preference ;—"and when the soldiers' lives, and the honour of England were at stake, English cutlery would not bear comparison with French !"

Sir John Jones, in his review of the operations, thus sums up :—"The most critical examination of the operations of this siege will not allow of blame for its failure being thrown on any one. From the general to the soldier each did his duty ; nor should the want of success discredit the original project. It must be admitted that there was a judicious application of all the means that could be collected for the reduction of Christoval. On trial those means proved insufficient ; many of the causes of their insufficiency could not have been foreseen, and others, if foreseen, could not have been remedied ; all that skill and bravery could effect was done."

Lord Wellington, in one of his Despatches, wrote, "I believe the failure in the attack upon San Christoval is, like many other events, to be attributed to the want of experience in the British army."

Napier, writing many years afterwards, with complete knowledge of the circumstances, and with due deliberation, declared that, "Fifteen days of open trenches and nine days of fire was all that could be expected, and with good guns, plentiful stores, and a corps of regular sappers and miners this time would have sufficed ; but none of these things were in camp, and it was a keen jest of Picton's, that 'Lord Wellington sued Badajos *in forma pauperis*.'"

Sir John T. Jones, in his "Journal of the Sieges," also remarked on the inefficiency of the Portuguese artillerymen, who "though brave and zealous, were very young and inexperienced, and after a few rounds their practice became very uncertain." And yet strange to say, in recording the siege operations at Olivença, a few weeks earlier, and which resulted in the capture of that fortress, and in which these same "young and inexperienced" Portuguese gunners worked the breaching batteries, the same writer tells us that "the artillery consisted of a company of Portuguese artillery under Capt. Jose de San Payo," and that, although "composed principally of young soldiers, showed a good deal of spirit and steadiness ; for though exposed to a brisk fire and a good deal of musketry, which killed two and wounded six others in the breaching battery, scarcely a shot was thrown away." In comparing Sir John Jones' account of

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the Siege of Badajoz, with the entries in Rice Jones' Diary, there is a curious similarity, which seems to suggest that the distinguished author of the "Journal of Sieges" drew extensively on his friend's "Diary" for the narrative.

Some idea of the inferior material with which this siege had been undertaken may be gathered from the Diary of Sir Alex. Dickson, who, as a Capt. of artillery was in charge of that branch at the siege; he wrote,—"The guns we got from Elvas for the siege of Badajoz were brass Portuguese guns of the time of John IV. and his son Affonso, bearing the dates 1646, 1652. Also some Spanish guns of 1620." The comment of Sir J. Jones on the operations is to the following effect:—"Everything else was on the same scale of inferiority, and it may be considered as fortunate that the approach of Marshal Soult's army caused the siege to be raised; as otherwise, after a further sacrifice of men in other feeble attempts, it would have brought itself to a conclusion from inability to proceed."

From June 22nd onwards, Jones was at Campo Major,—"assisting Capt. McCleod in the erection of a line of sham works towards Ougella, an old castle, occupied by a few Portuguese." Early in July, he joined the Light Division,—"bivouacing in the woods, where we continued quiet until the 23rd; when Head Qrs. removed to Portalegre, and the Light Division occupied Castello and the adjacent villages; but I was not well enough to accompany it, and remained at Elvas until the end of the month. *August* 3. Rejoined General Craufurd at Bemposta."

(Undated—probably July).

My dear Father,

There is nothing new to inform you since my last. I am now with the Light Division on the Caya, about 3 leagues above Elvas; the rest of the army are on the same river or in its vicinity, between Arronches and Elvas, and Head Qrs. are still at San Vincente. We have heard nothing certain of the enemy's movements lately. General Craufurd has thus far behaved civilly enough; and Ross and his troop of Horse Artillery, who are attached to the Division, are particularly kind. . . .

P.S.—Since writing this I find that 2 Divisions marched this morning towards Castello Branco, and it is said the others will follow.

Note.—The Light Division resumed its march on August 7th passing a village very beautifully situated in a "wood of beautiful Chestnut trees, and near a very fine stream of running water;" and bivouacking for the night in a wood of fine large chestnut trees. Thence onwards, till, on the 9th Fuente Guinaldo—just inside the Spanish frontier—is reached—"a good town; the best we have seen since we quitted the Alemtejo." Next morning the march was resumed before daylight, and Mortiago reached the same evening, in heavy rain.

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From Capt. S. R. Chapman.

PALL MALL, *Aug.* 6, 1811.

DEAR JONES,

. . . I think it likely you will soon be ordered home, to take possession of your appointment to one of the Adjutancies; I suppose in the first instance you will go to Woolwich. . . . As your new appointment is of a permanent character, at any rate it is so till further promotion . . . I hope you feel more comfortable with an Epaulette, tho' with a Frinze; the rank you have obtained is I think one of the most important steps in our Corps. . . .

The R.M. Artificers, which I hope will soon be called Royal Sappers and Miners, are to be taught to construct Batteries, Trenches, etc., etc., and I hope with the care that is to be taken to instruct them properly, they will be found to be a very useful body of men. . . .

Yours ever sincerely,

S. R. CHAPMAN.

Addressed to:—

CAPT. RICE JONES,
Royal Engineers,
British Army, Portugal, Lt. Division.

Aug. 11. Marched at daylight; lay upon our arms at Zamarra for some time, until Genl. Murray came and ordered us to march towards Ciudad Rodrigo. At the ruined Convent of Caridade met some squadrons of Dragoons, and Cpt. Bull's troop of Horse Artly. Left the Division near the ford by the Convent, and went with General Craufurd to reconnoitre the place, taking 20 of the Royal Dragoons as our escort. Rode round at the distance of 1,000 to 1,800 yds. from the works, to the height in front of San Francisco. The new work constructed by the French appears small; the ditch seems respectable, and the work well manned. New embrasures are making in the principal enceinte of the place, particularly in the faces fronting the suburb on the Salamanca Road. In the afternoon we returned to Martiago by the same road, a good deal fatigued from the heat of the day, and the roughness of the roads.

NOTE.—In explanation of the above, it may be stated that Wellington, so Napier writes, learning from an intercepted despatch that Ciudad Rodrigo was in want of provisions, and hoping to profit from this circumstance, crossed the Tagus at Villa Velha early in August, and moved by Castello Branco towards that fortress, pretending he sought healthy cantonments. He had already planned to take Rodrigo by surprise; for which purpose he had caused a battering train just arrived from England with their gunners to be secretly landed at Oporto, carried up the Douro in boats to Lamego, whence they were taken to Villaponte near Celorico, without attracting attention. "The bringing of 68 huge guns, with proportionate stores across fifty miles of mountain was an operation of magnitude; 5,000 draft

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bullocks were required for the train alone, and above 1,000 militia were, for several weeks, employed merely to repair the road; the effort,"—adds Napier, "marred one of Napoleon's formidable projects."

August 15. Hearing the French are making an incursion into the Sierra, General Craufurd set out with an orderly Portuguese dragoon and myself through Saugo to the Puerto, or pass above Gata—distant 4 leagues, the greater part footpath, through low brushwood, etc. After some consideration we descended the pass on the South side by a paved road for about a league to the town of Gata; met a Spaniard with a letter concealed in his clothes giving an account of the visit of the enemy to the towns in the Sierra, and stating they retired from Gata in the morning. Although Gata is an inviting town, and the inhabitants appeared well-disposed, the General conceived it would be imprudent to sleep there, as the enemy's movements were unknown, and seemed uncertain. We therefore went a league further to Cadalso; upon our arrival found a French Proclamation just posted up in the Market-place; but being too tired to proceed, were obliged to stay at Cadalso; from whence the next day we returned by Escargo Maria and Robledilla to Martiago.

MARTIAGO, *August* 14, 1811.

MY DEAR FATHER,

Since my last letter we have made rather a long march, and instead of being near Badajoz, we are now about 3 leagues from Ciudad Rodrigo. A variety of reasons are assigned for this movement, but I am so utterly ignorant on the subject that I will not venture to send any one of them. Some say we are going to besiege Ciudad Rodrigo, but of this I must confess I have some doubts. We arrived here on the 10th inst., the next day we made a kind of reconnaisance of the place, and returned here in the evening; since when we have halted, and are cantoned in the neighbouring villages. Where the rest of the army are I cannot tell, but I believe somewhere on this side of the Coa. Head Qrs. are at Fuente Guinalda, 3 leagues west of this village. I am extremely comfortable with this Division; it is always in front, and if anything occurs is sure of having its share. General Craufurd is particularly civil, and although he rides hard every day, and knocks up my horses, which are not the best in the world, yet he keeps one of the best tables in the army, and as I live with him, and my health is such as to enable me to stand the fatigue, I do very well.

I have not heard a word of the Adjutancy;—indeed I would rather not (whilst there is anything going on in this country) be ordered to return at once. It is very odd that Major Chapman has not answered any of my letters on the subject; but I suppose he is very busy, or, else, like some others, has learnt the importance attached to an official character, whether in the Ordnance Office or the Inspector-General's.

I have not a word of news to write to you this time. . . .

Your very affectionate son,

RICE JONES.

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NOTE.—The following letter, which appeared in the London *Times*, may well find a place here at this stage of the war :—

From THE TIMES of 1811.

THURSDAY, AUGUST 29.

TO THE EDITOR OF THE TIMES

SIR,—As the public seem at present rather out of spirits respecting our progress in the Peninsula, and as the great influence which *The Times* possesses over the public sentiment has always been exerted in supporting the determination of the country to maintain its honour and existence, I submit to you a few ideas, which will, I am persuaded, give a material turn to the sentiments of our countrymen, who are too apt to be elated beyond reasonable bounds in the hour of success, and unnecessarily dejected, if the prospect appears even *momentarily* altered.

When Lord WELLINGTON was following MASSENA to the frontiers of Portugal, Englishmen expected that the whole French army (150,000 men) were to be driven over the Pyrenees in six weeks. His Lordship is now on the defensive; and we begin to contemplate the probability of a return to Torres Vedras. Let it, however, be recollected, that Lord WELLINGTON'S movements, though not marked with the brilliant results of great victories—of captured cannon, of standards, or wounded prisoners,—have yet had the following *solid* effects :—

1st. *The recovery of the whole province of Asturias*, and the consequent advantages of recruiting the Spanish force by new levies—of posting those levies in almost inaccessible mountains—and of lessening the resources (of subsistence, etc.) of the enemy. 2dly. The recapture of Astorga, which cost the French a long siege, and near 2,000 men. 3dly. A loss to the foe of not less than 4 or 5,000 men, from desertion (see accounts from Corunna), sickness, and fatigue (*vide* SANCHEZ' action, etc.). 4thly. Immense fatigue to the French forces, who have marched several hundred miles, and have now to retrace their steps. And 5thly. The increase of the Spanish Guerilla force, which has received an accession of at least 4,000 men. Are not these results fully equal to any thing which even a splendid victory could have produced? And these results have been produced without our having to regret the loss of five or ten thousand brave men.

In a word, is the situation of the French improved since August, 1810? Are they nearer to the conquest of the Peninsula? In August, 1810, they had 200,000 men in the country—were acting on the offensive, and penetrating into Portugal. They have now about 136,000,—dare not look at Portugal,—have lost 10,000 square miles of the territory they held in Spain,—and are everywhere on the defensive;—and so threatened and harassed, as to be obliged to run from one post to another to meet the threatened attack,—first rushing to the south, and then hastening back to the north: one moment assembling—again subdividing; and daily losing men, ground, and *confidence*.

I am, etc.,

Norwich, Aug. 24. R.M.

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August 16. Bivouac near El Casar. Proceeded with Lieut. Scott, 95th Regt., to Robledilla and instructed him to post himself and his party of the 95th to guard the pass. Procured a guide from Robledilla, and went along the Eastern ridge of the valley running from Robledilla to Cadalso, for some distance; then took a turn to the left and descended into a cultivated country, and soon after reached Torricilla; stopt there but little, the enemy being in Villa Nueva, about 3 miles and within sight; proceeded to El Pino and from thence to Cavar de Paloma, where I met Capt. Grant who is employed to obtain intelligence, and was well known to all the people in the neighbourhood. After dining with him, rather scantily, we led our horses by some by-paths to a garden near a brook, where Grant thought we might sleep in security under the shelter of some Olive trees.

August 19. Breakfasted on Roasted Potatoes, and left Grant, proceeding by El Pino up a narrow valley never visited by French or English, and, from its situation, nearly inaccessible. Ascended by a long and dangerous path to the Puerto Vieja, from whence the descent is much easier to Martiago.

August 22. Accompanied Genl. Craufurd to Mayllo, through Moras Verdes, in order to make ourselves acquainted with the country. *Aug.* 23. From Mayllo we proceeded through Cuceado to Sequeros, a village finely situated near the right of a hill looking over Miranda de Castanar to Bijar; but troops of the enemy being close round us, and expected to arrive for their rations levied on the village, we remained only long enough to bait, and descended to Villa Nueva del Conde, a larger place, but not so pleasing; received with acclamations when known to be English; but passed through without stopping and proceeded by an intricate road through Valero and San Miguel de Valero, to Linhares, where we remained the night, and were well entertained by the Padrè Curé. Returned to Martiago next day, by a different route.

MARTIAGO, *August 28th*, 1811.

MY DEAR FATHER,

. . . The day before yesterday I received a letter from Major Chapman, wherein he tells me that upon General Morse's resignation he had not failed to speak to General Mann about my Adjutancy, though he did not believe that his former application would have been passed over, "besides which," says he, "Handfield is much your friend, and I think it likely you will soon be ordered home to take possession of your appointment; I suppose in the first instance you will go to Woolwich; let me know how you will like this." He likewise states his expectation of seeing the Ryl. Military Artificers called Ryl. Sappers and Miners very soon; and as they are to be drilled in the construction of batteries, trenches, saps, &c., trusts that they will prove a useful body of men; I hope they may, but I cannot say that my expectations are very sanguine on that head; altering their name is undoubtedly doing something, but

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whilst they are kept constantly at work in the different shops at Woolwich, Chatham, or Portsmouth, and without officers who can be responsible for the companies wherever they may be, (which is at present the case)—for the Commdg. Engineers have neither the time or inclination to undertake the task, and the superannuated Sergt.-Majors, who were, 3 or 4 years ago made Sub. Lts. are totally incapable of it. If they will give me the charge of a Battalion, to be disciplined like other soldiers, and taught sapping, etc., so as to be useful in the field, I shall feel happy in devoting my time to the attainment of what will prove so highly useful to the service, and creditable to ourselves. But if the name only is to be changed, and the men, after working all the week, are to be drilled and become soldiers on Sundays, and the King's Birthday, only, I shall for ever regret my having returned from such a desirable and honourable service, to partake of the disgrace that such a set of undisciplined Vagabonds must bring upon anyone that has anything to do with them.

I enter thus largely upon this topic, that you may not be surprised if, upon my entering into the duties of my Adjutancy and finding it impossible to discharge those duties creditably, I should without hesitation prefer (as I undoubtedly ever will) to return to my duty as an officer of Engineers, wherever they may choose to send me. However, I now indulge somewhat of the hope of getting a respectable Battn. of Sappers; and future armies will not, I trust, find themselves before another Badajos, without a single man who had seen, much less worked, at a *Sap*, which requires so much practice to carry on at all; whilst at the same time the French Corps of Sappers and Miners are the finest body of men in their army.

We remain here exactly the same as when I wrote to you last; but the enemy have within these few days past evinced an intention of moving from Plascencia and Valladolid, so as to prevent our besieging Ciudad Rodrigo, for which purpose every preparation has been making; although I do not believe that we can under present circumstances venture to take our battering train, etc., across the river Agueda; and without which we cannot undertake the siege. A week or ten days will probably show us what they intend doing. I do not feel very confident that we can remain very long so far advanced into Spain as we are at this moment. I shall do all in my power to remain with Genl. Craufurd until things take a turn, either one way or the other. If the army advances we shall be in front; and if it retires, our Division will form the Rear Guard. Added to this the civility and attention I constantly receive from the General, and you will, I am sure, agree with me, in conceiving it highly desirable that I should remain here whilst any active service is going on. They are not in general very quick at our office, and I therefore hope I may not receive my orders to return just yet.

Should I land at Falmouth or Plymouth, I will not fail to see you on my way to London, at least if you are at Bristol, or anywhere near the road; but, as affairs now are, I think you had better continue writing to me here. . . .

Your very affectionate son,

RICE JONES.

(*To be concluded*).

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TRANSCRIPT.

NATURAL *POINTS D'APPUI.*

From an article by V. Polyanski entitled "The Influence of the Psychical Element, in Conjunction with Other Factors, upon Fortification Types," in the April, 1912, number of *Injenerni Jurnal.*

LOCALITIES which may serve as *points d'appui* in a defensive line are very varied in character. Under this heading may be included villages, woods, groups of buildings, separate buildings, groves and parks. Hills are not included as the nature of their defences bring them within the category of artificial *points d'appui.*

Not all of the above-mentioned localities are suitable for occupation as *points d'appui.* Those for instance which are of small extent are liable to rapid destruction by the concentrated fire of modern artillery. But such localities, and especially villages and woods, as can be placed in a state of defence by simple methods and by their own garrisons, are largely even in these days adapted to very vigorous defence.

We will discuss this matter by taking in turn the following conditions which are necessary to *points d'appui,* and will inquire whether any of these conditions, and, if any, in how great a degree, are satisfied by the localities mentioned.

(1). *Vigorous Defence during a Prolonged Period.*

This condition requires a definite strength of garrison (1 to 2 battalions), frontal and flanking fire, sufficient fire in rear to protect the obstacles, all-round defence and obstacles. All of these requirements are satisfied by villages and woods. Their comparatively long extent of front admits of strong frontal fire, while the irregular line of their borders gives flanking and cross fire and rear defence. Very large woods however are not suitable for *points d'appui.*

In each, but especially in woods, there is a large amount of material available for obstacles, and in each a succession of defensive lines may be organized. These qualities are extremely favourable to vigorous defence, and military history contains countless examples which confirm this view.

(2). *Defence of Approaches to Neighbouring Sections.*

This condition is extremely difficult of realization in field warfare. If a permanent fort, which may come under the fire of artillery, is unable to sweep the approaches to its neighbours except by special arrangements such as shields and armoured galleries, the difficulty of this requirement is naturally greatly increased under field conditions.

This is partly due to the artillery fire which may be brought to bear

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upon the locality, and which would prevent the men from manning the firing positions from which the flanking fire is directed, and partly to the instinct of self-preservation which would prevent men from attending to other sections while their own is in danger. If the attack is directed upon the *point d'appui* under consideration as well as upon its neighbour, this instinct compels the men to turn all their attention to the nearer danger. But if they are not threatened by immediate danger they can find, in the comparatively long broken line of the locality, points from which a fairly large number of rifles can be concentrated in the desired direction, and screened by the locality reserves can be brought up for a counter-attack more easily than in the case of a redoubt or other artificial *point d'appui*.

(3). *Cover from the View and Fire of the Enemy.*

The complete cover from the enemy's view which is afforded by all such localities without the expenditure of any labour, and the feeling of confidence thereby inspired in the garrison are of great material and moral value.

To ascertain by reconnaissance what localities are occupied for defence and what are only screens and false *points d'appui*, has become a matter of considerable difficulty, not only previous to a battle, but also owing to the use of smokeless powder, even during the battle itself. Successful concealment from aerial scouting can only be obtained by occupying these localities, as has been proved during recent Russian, French and German manœuvres. However carefully artificial works have been disguised, it has been found impossible to conceal their trenches and banks from the eyes of airmen or from the plates of their cameras. It is true that the defences of localities must also be carefully disguised, but this requires less skill and is more successfully accomplished than in the case of works in the open field.

Trenches must no longer be made in advance of the outskirts, but the outskirts themselves, or better still a line in rear of them, must be prepared for defence. In addition to the ordinary rules for concealment, trenches should now be made narrower than formerly and should be covered with any available materials, such as great-coats, brushwood, branches, etc.

From recent experiments it has been found that woods and shrubs give complete cover from airmen, even for men moving along roads. In villages, it is recommended that there should be less moving about, and that advantage should be taken of the shade given by houses and trees. In the open, on the appearance of aircraft, men should lie down and cover themselves over with their cloaks, etc.

All artificial works constructed in the open are clearly distinguishable by aerial scouts, especially the regular outlines of redoubts, etc.

When one considers the exceptional importance which is now attached to concealment, it may be positively stated that this property of localities has greatly increased their value in recent years.

We will now consider the cover which they afford against the enemy's fire. In this case if we judge by theory only, we will arrive at very dismal conclusions. The accurate and destructive effect of modern

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artillery fire appears to answer the question of their occupation once and for all.

A brick wall must be two bricks in thickness if it is to stop modern rifle bullets; villages and woods give good protection against shrapnel bullets and splinters, but the action of the high-explosive shell of field howitzers upon them is very destructive.

"The tremendous moral effect of bombs of large calibre, the shriek of bursting shells augmented by the echo in woods or in enclosed villages, the dense coloured suffocating smoke enveloping everything as with a shroud and hiding the country in all directions, the demolished and overturned guns, limbers, etc., the mutilated corpses, the din and crash of falling houses, the smoke and heat of bursting flames, will make of the future position such a hell, that the man who can preserve his calmness, retain self-possession and steadily perform his duty, must possess 'a heart of iron and nerves of steel'" (Golenkin). If this were actually the case, then the fate of *points d'appui* would be sealed, their garrisons would fly in panic or suffer annihilation.

There have naturally been no experiments in peace time in the shelling of localities. It remains therefore to examine the experiences of war, and to search how we may discount in future battles the fire of modern artillery.

War experience does not confirm the prognostications of the decisive action of artillery fire upon localities. It is true that we have now to deal with the high-explosive shells of large calibre howitzers, but these are much more dangerous to targets of small dimensions like redoubts than to the comparatively large areas of localities. In some respects the old black powder was more dangerous to woods and villages than the modern high explosives. We will endeavour to show how this is the case.

The most effective qualities of modern field artillery fire are the *low trajectory* of the guns, and the *accuracy* of howitzers when searching areas. From their low trajectory the action of the common shell of field guns will be expended entirely upon the outskirts of localities. Shells with sensitive double-action fuzes will explode when passing through trees and hedges, and therefore all bursts will occur on the outskirts. Their splinters will act only weakly, as their sphere of damage will be considerably limited by buildings and trees.

The French at first thought that the introduction of high-explosive shells would annul the value of villages as *points d'appui*, but some experiments which were made with the object of testing this changed their views, as is shown by the following words of General Langlois:—"It would be sheer foolishness to repeat the demolition of the enclosures of Fröschwiller, St. Privat, etc., as the defensiveness of a village would be little weakened by doing this; in rear of the first enclosures there would be second, third and successive lines of defence, depending in number on the depth of the village. To demolish the whole village, the high-explosive shells of a whole Army Corps would not suffice."

The high-angle fire of howitzers has enormous local effect, both material and moral, but from its very accuracy, if it is desired to search

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the whole area of a locality, it is necessary to disperse the fire and thereby to reduce its effectiveness, as the war establishment of howitzers is very limited. If the fire is concentrated on one section, the rest of the area would not be affected.

General Langlois writes:—"To demolish a village with high-angle fire could of course be done, but it would be sheer foolishness, if one thinks what a quantity of shells such an operation would require; the results obtained would always be so small that they would in no case justify the trouble and expense which the destruction of an inhabited area would involve."

The fact that localities are shown on maps would presumably facilitate ranging, but actually it does not have this effect. When firing with guns of large calibre the state of the atmosphere, light, and other conditions are important factors, and the measuring of ranges is not so essential as immediate observation of the results of the firing. The outskirts of a locality will rarely be accurately shown, very often they are irregular, disconnected and concealed by bushes and trees, while the depth of the target adds to the difficulty of deciding the actual distances of hits. It is extremely difficult to observe the bursts of shells among houses, and still more so in a wood. All this complicates the ranging and carrying out of effective fire, as was clearly recognized by those who witnessed such firing under war conditions.

Many people place great confidence in the incendiary action of shells and believe that the heat of burning houses would prevent the garrison from defending a village. But modern high-explosive shells have weak incendiary action, as has been shown by recent experiments, and in this respect are considerably inferior to those filled with the old black powder. The rapid burning of high explosives would allow them to set fire to buildings only in exceptionally favourable circumstances, and if the measures recommended in the text-books on fortification are duly taken such favourable circumstances should be avoided.

In the war of 1870–71 there were numerous examples of the ineffective action of artillery against localities. The same thing occurred in the Russo-Japanese War, and the results of the latter being nearer to our own time are more convincing and instructive.

Many examples can be produced in which strong concentrated artillery fire did not produce any material results, but we will limit ourselves to noticing two which we consider the most characteristic. The assault on the village of Sandepu, which ended unfavourably for the Russians, was prepared by the fire not only of field but also of siege guns. On the 25th January 50 guns acted upon this village, on the 26th 156 guns, on the 27th 88 guns, and on the 28th 104 guns. In the same action on the 25th January 56 guns acted against the neighbouring village of Heigoutai. A plan of Sandepu is attached.

In the battle of 27th February large masses of Japanese were concentrated in the village of Lamatun, for counter-attack upon the Russians who had just carried the Black Copse. Against this village the Russians opened fire with 100 guns of heavy calibre, besides some of the Field Batteries of the XVII. Army Corps, the range having been already

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decided. In spite of this the Japanese debouched from the village and recaptured both the Black Copse and the lunette nearest to it.

The experience of the Russo-Japanese War convincingly showed that villages make excellent *points d'appui*.

But the question naturally arises:—May there not have been certain peculiarities in the Chinese villages to make them such superb *points d'appui?* This is partly true, but only partly so, as it is not the security of the cover afforded by them that causes the obstinacy of the fighting in localities. In many of the villages after the artillery bombardment there did not remain a single house, a single enclosure wall, with one stone left upon another. But these heaps of ruins which had lost all semblance of bank, trench, stove, etc., gave facilities to the garrison, hidden in neighbouring folds of the ground, or in trenches, or in the village itself, if its area is large and there is room to manœuvre, to reoccupy the firing line, on a wide front and from several directions, and to meet the attacking infantry with severe fire in any desired direction. All ruins give more or less good cover from rifle fire. Shrapnel and splinters, and the high-angle high-explosive fire of the attack must be stopped in good time for fear of injury to their own men, as the splinters may fly backwards for 200 to 300 paces.

Woods have the same properties as villages if they are not too large and not too small. The garrisons can find cover from low trajectory fire by going back from the edge about 100 metres, and from high-angle fire by moving from the parts more heavily bombarded to those less so, for the enemy is unable to follow the movements of parties of the garrison or of the reserve.

War experience has shown that the damage from splinters of timber and from falling trees is never great, as is ordinarily supposed, and that the losses from fire are very small.

The moral effect of shells both in villages and woods is undoubtedly great, but the same war experience has shown that only troops whose *moral* has been shaken by excessive destruction fail to endure it, and fly from the field, failing to occupy the locality before the assault of the enemy's infantry.

Localities, such as Russian villages, consisting of wooden buildings with thatched roofs, cannot serve as *points d'appui* without special engineer arrangements, but they may be used as screens, or for drawing off the fire of part of the enemy's artillery, and thereby lighten the task of the real *points d'appui*.

(4). *The garrisons of localities.*

Some opinions exist that the defence of localities requires very large garrisons, but opinions contrary to these also exist, as for instance a German writer states:—"Woods and villages must be occupied by the smallest possible garrisons; the fault of carrying this rule to excess has happened on very rare occasions, more rarely than the reverse, the assignment of very large forces for the defence of villages."

By the rule proposed by us the garrison of a locality must be 1 to 2 battalions. If it is remembered that a vigorous defence is required possibly for several days, as at Sandepu, it would be risky to assign a

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weaker garrison; besides this, 1 to 2 battalions cannot be considered as an excessively strong garrison.

(5). *All the work of defence to be done by the garrison only and in the shortest possible time.*

The majority of localities may satisfy this condition, as in the course of one night a garrison of 1 to 2 battalions can make a firing position and can strengthen it with obstacles. If there is time for further strengthening, the locality can be gradually converted into a post of extraordinary strength (Sandepu, etc.). From the sketch it will be noticed that Sandepu was not surrounded with a complete ring of obstacles.

We may sum up the case as follows:—Localities have an irresistible attraction for troops, due to purely psychological causes, and it may be taken as a rule that in the past they have always been occupied, and that they always will be occupied in future. The new factor in war, aerial reconnaissance, reveals the fact that not only has the value of localities not lessened in recent years, but on the other hand that it has increased. Investigation of their properties shows that their occupation and defence present solid advantages to the defenders. They therefore make excellent *points d'appui* in field warfare.

In conclusion we would note that owing to the properties of modern firearms the main fight will take place behind the outskirts of the locality, and therefore special attention must be paid to the preparation of the first line. The construction of trenches in advance of the outskirts will be exceptional (though sometimes they may be necessary to obtain a special field of fire) partly on account of concealment, but also because of the necessity of connecting these trenches with the rear by communication trenches, as there would hardly be time for doing this under the conditions of field warfare.

Available material must be abundantly used in the construction of light types of cover, and these must be distributed all over the area in various places; it might then be possible to keep the troops of the garrison within the locality during the artillery bombardment, an arrangement which is always extremely desirable.

F. E. G. SKEY.

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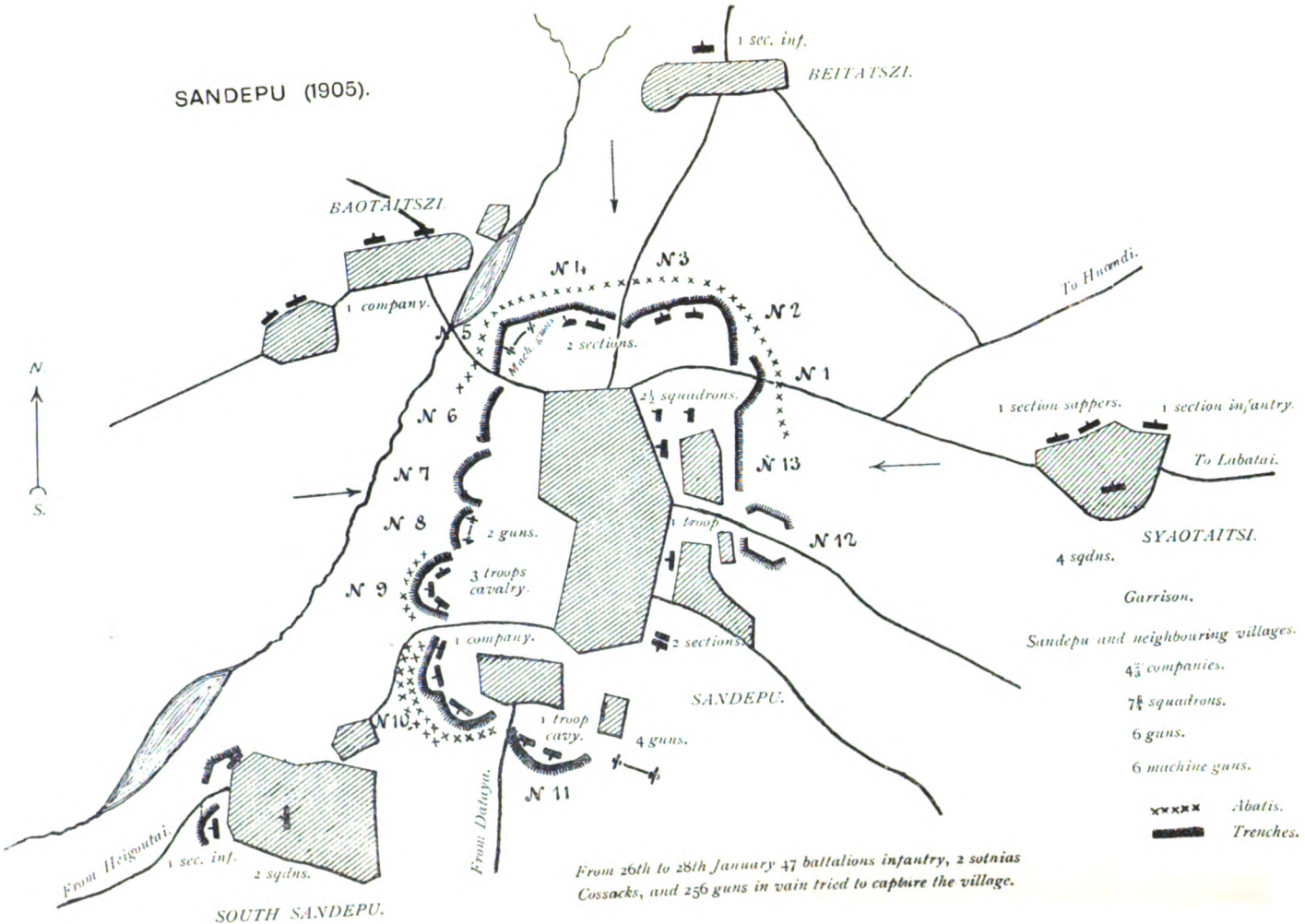

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NOTICES OF MAGAZINES.

BOLETIN DE INGENIEROS.

January, 1912.

MILITARY AVIATION.—The author, a captain in the Mexican Engineers, describes in his article the progress of military aviation in France, and lays down the special qualities required in a good airman. He points out how, with the exception of a few very daring professional aviators, the two chief parties interested in aviation are the builders of aerial craft, and flying officers. As regards the commercial class, the constructors of aeroplanes for a time went through a sort of financial crisis in France. The number of machines sold diminished, owing to the decrease of civilian aviators, and it was not until the press pointed out how disastrous it would be to France for her aerial craft factories to fail, that a fresh impulse was given to aeroplaning in the army.

The main qualities required in a military aviator are perfect health, bodily strength, good eyesight, steady nerves, and sound knowledge as an engineer, mechanic and soldier. The importance of free runs and captive ascents in spherical balloons cannot be too much emphasized, as it both aids the aeronaut to get a knowledge of the state of the atmosphere, and to develop his powers of observation at various heights.

After pointing out the expenses of maintenance involved by aeroplanes, and the necessity of having at disposal a large *personnel* of mechanics, carpenters, riggers, etc., with all the shops and tools they require, Capt. Cervantes goes on to show some of the special difficulties which will have to be faced in Mexico, apart from the present lack of any trained pilots. These difficulties are the extreme rarefication of the atmosphere, due to the high altitude, the lack of means of transport and the bad state of communications in the country.

To undeceive those who fondly imagine that aviation is a cheap pastime, the following figures are quoted, showing what aviation has cost the French Government:—In 1909:—240,000 francs for experiments only; in 1910:—2,000,000 francs; in 1911:—3,120,000 francs; in 1912:—(estimate) 7,600,000 francs. At the beginning of 1912, France had actually 50 aviators, so that each pilot cost about 100,000 francs to train.

August, 1912.

MILITARY AVIATION.—This article is also written by Capt. Cervantes and its object is to point out how far aeroplanes can at present be used in warfare. He begins by showing the difficulties of landing and rising

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again, feats which in a specially selected place like an aerodrome appear to be easy. He also insists on the special conditions existing in Mexico as regards the atmosphere, owing to the great height above sea level of parts of that country, and how adversely this will probably affect the work of the two foreign aviators who are at present being used by the Huerta Division in the north of the Republic. He adds, that, although they may be animated with the best intentions in the world, these airmen have no knowledge of the climate or country in which they are working. Moreover, of what interest is it to a flying column in guerilla warfare to know that there are 30 or 40 armed men 50 kilometres away? The use of the aeroplane in this type of warfare is apparently very small.

Capt. Cervantes ends by saying that the present employment of aeroplanes in the Mexican Army may be useful, mainly to accustom the troops and the inhabitants to their appearance, but as regards practical results, they will be *nil*.

September, 1912.

There is an article on the aeroplanes with the Huerta Division which consist of a 50-H.P. Moissant Bleriot, and a 100-H.P. machine of the same firm, built to carry passengers.

A. H. Scott.

Rivista di Artiglieria e Genio.

September, 1912.

Bulgaria.—*Mitrailleuses for Cavalry.*—The Bulgarian cavalry consists of 2 independent brigades—each of 4 regiments of either 2 to 4 or 2 to 3 squadrons—and 1 brigade of 3 regiments of 3 squadrons, intended to form together with the gendarmerie the divisional cavalry. Each of the 3 brigades is said to be furnished with a mitrailleuse section. The *Bulletin de la Presse et de la Bibliographie militaires* of the 31st July states that 1 section of 4 Maxim mitrailleuses is to be assigned to each of the 4 regiments of 4 squadrons of the independent brigade.

Military School.—The *France Militaire* of the 11th July states that a military school will be initiated in Bulgaria with courses from October, 1912. The officers who apply for admission are required to have not less than 4, and not more than 8 years service, and have to pass the prescribed examination for admission. The number of students must not exceed 20 for each course, and the period of the studies is 3 years.

France.—*Apparatus for Bomb Throwing from Aeroplanes and Dirigibles.*—*La France Militaire* of the 19th July states that a "sight" has been invented for determining the instant at which to let fall projectiles from aeroplanes and dirigibles so as to strike the target. The apparatus consists of a pendulum, in the form of a truncated cone, enclosed in a cylinder. Special arrangements, the use of a very dense liquid which

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will not freeze in winter, protection from the air currents, etc., give great stability to the system, which indicates the vertical when the aeroplane or dirigible is passing over a position. The apparatus also rapidly shows the inclination of the airship and the angle which a line from it to the target makes with the vertical. It also permits of calculation for the velocity of the airship, when the proper indicator of velocity is wanting. The field of view of the apparatus from a height of 1,000 m. has a radius of 200 m. around the vertical. Special fire tables placed in front of the apparatus permit of establishing rapidly—given the altitude and velocity of the airship—the inclination noted by the passing observer at the instant he lets fall the projectile so that it may reach the point required.

Aeronautics in the French Army.—We read in *La France Militaire* of the 9th August, that a dirigible and several squadrons of aeroplanes—probably 6, with 6 apparata each—will be assigned to each Army Corps this year during the grand manœuvres. An Army Corps will also have some aviation sections for artillery.

Boats for Cavalry.—The same journal of the 7th—8th July notes that a brigade of cavalry has carried out experiments for crossing rivers by means of a special type of boat. Each cavalry regiment has two of these boats, or pontoons, attached to it, and they can easily be carried by four men. The two boats complete with accessories have a weight of 2,000 k.g. and are transported on one wagon.

Pilot Officers for Aeroplanes and Dirigibles.—The *Bulletin de la Presse et de la Bibliographie militaires* of the 31st July states that the French War Minister has approved of officers, who have obtained the brevet of military aviator or of dirigible pilot, increasing by 30 points the total they obtain at the various obligatory trials carried out at the War School.

GERMANY.—*Exercises for the Use of Search Lights in Warfare.*—The Russo-Japanese War, by showing how the power of modern armaments forces belligerents to make large use of nocturnal operations, has drawn the attention of all armies to the employment of search lights. In Germany, particularly, steps are being taken to accustom the troops to such means, and exercises have been arranged in which the troops have search lights at their disposal. The January number of the *Journal des Sciences Militaires* gives some rules which are adopted in Germany for such exercises. The average useful limit of distance for the light search lights used by the pioneers is 1,500 m., and that for strong fortified places is much higher. However, the conduct of the troops exercised under the conditions of search lights should be independent of their power. Battalions should first be exercised singly, then brigades and divisions. When the use by the enemy of search lights is feared, it is necessary to avoid all objects which reflect the light. Drums, bugles, etc., should be covered with stuff. Horses should be left in the rear; the officers and troops should all move on foot. On the march all means of illumination, even covered lanterns, should be forbidden. All the men of each detachment should stretch themselves on the ground and remain immovable when in the vicinity of the luminous rays of a search light; and remain so until they are discovered. If the enemy's search light is

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sweeping the ground regularly, it is necessary to move only when it is turned on to some other point. Companies should move as far as is possible with a small front which allows of their being less visible. Detachments on the march should avoid high ridges and crests, and should avail themselves of places such as the edges of woods, where the luminous rays cannot reach them. Intermittent illumination is most advantageous. The time during which a zone of ground is illuminated should be utilized to point the mitrailleuses, and to make special arrangements for the rifle fire to cover the sector assigned to the detachment. The defenders, except the few told off for observation, should remain concealed as far as is possible. As regards the destruction of search lights by means of a violent fire of rifles and mitrailleuses, experience shows that the estimated distance is very uncertain, and the aiming difficult. Except for very short distances, there is small chance of destroying a search light by the infantry; with shrapnel fire however there is a greater probability of success.

Mitrailleuses on Airships.—*La France Militaire* of the 13th July refers to the new German dirigible Parseval P.L. 8 which is said to be provided with two mitrailleuses as well as with a tube for throwing bombs, and the new dirigible Zeppelin *Z.* III. is also equipped with a mitrailleuse placed in the front of the airship.

Inspector of the Corps of Engineers.—We read in the *Bulletin de la Presse et de la Bibliographie militaires* of the 31st July that the title of Inspector of the Corps of Engineers and Fortresses is abolished and in its place there is an Inspector of the Corps of Engineers, whose duties comprise the inspection of the pioneers, of the troops of the lines of communication, and of fortresses—all three new formations.

New Instruction for Cavalry.—Under the date of 20th June new regulations for equitation (Reitvorschrift) are published. These apply to other arms besides the cavalry. Those of the field artillery and the train are contained in the Supplements I. and II. In the new regulations a new pattern of bridle is introduced.

E. T. THACKERAY.

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CORRESPONDENCE.

DEMOLITION OF HIGH WIRE ENTANGLEMENTS.

DEAR SIR,

On reading the transcript in the *R.E. Journal* of August last, regarding the demolition of high wire entanglements, I determined to expend a portion of my annual allowance of guncotton on a similar experiment.

The charge was made up exactly as described, except that the metal cap was dispensed with; a solid wood head being substituted. The charge was 2-lb. guncotton slabs cut into thirds, *i.e.* $1\frac{1}{3}$ lb. per foot-run, with a half-slab at every 4 ft. to facilitate priming. Total charge, 26 lbs. distributed over a length of 16 ft.

The entanglement was of the usual type.

The charge was fired electrically, and the result was practically *nil*. The posts nearest the charge, *i.e.* within 3 ft., were cut through at ground level and one wire was cut, but nothing in the least resembling a gap was formed.

Yours faithfully,

C. W. BUSHELL,

Lieut., R.E.

Mandalay, 6th November, 1912.

The Editor, *R.E. Journal.*

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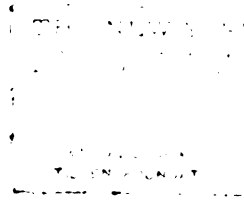

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"Nose."

"Live handle." "Nose."

rpedo 19' 6" long.
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No. 1.—The Bangal

Showing three interchangeabl
Weight of each (loaded with $1\frac{3}{4}$ lb
Material of tubes,

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THE DESTRUCTION OF WIRE ENTANGLEMENTS.

A SUGGESTED METHOD.

By Bt. Major R. L. McClintock, d.s.o., R.E.

Since attention was drawn by the Siege of Port Arthur to the great difficulty which the attack experiences in coping with the wire obstacles of the deliberate defence, and to the very small effect produced on these by even a protracted bombardment with high explosive shell, a good deal has been written both at home and abroad on the best methods of dealing with such entanglements.

Suggestions divide themselves into several classes, which are thus summarized in M.F.E., Section 48, viz. by :—

I. Building a roadway *over* the obstacle, with ladders, planks, hurdles, etc., etc.

II. Clearing a road *through* it, which may be done in various ways,

(*a*). By dragging the whole, or a portion, away with grapnels.

(*b*). By cutting the wires *one by one* with cutters, billhooks, axes, etc., etc. Also with bullets, the wires being caught singly in a special clip affixed to the rifle-muzzle and then cut one at a time by its repeated discharge.

(*c*). By cutting the whole breadth of the obstacle *at once* by firing an elongated charge of explosive placed by hand on, in, or underneath it.

To compare these various methods, certain experiments have recently been carried out by the "Q.V.O." Sappers & Miners at Bangalore, of which the following are the results. The obstacle attacked was the ordinary high barbed wire entanglement, 18 ft. in width, the posts being from 4 in. to 6 in. in diameter and of height varying from 5 to 8 ft., so as to render the upper surface of the entanglement uneven (M.F.E., Section 44).

1. *Method I.*—Forty men with grapnels failed to produce the slightest effect on the entanglement in a quarter of an hour, except breaking an odd wire or two. Barring an apocryphal case in the South African War, where the Boers were said to have dragged away the entanglement of a blockhouse with the aid of a span of 16 oxen, I have never heard of this method being successful. It is hard to see

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how it could succeed, if the entanglement was at all properly anchored down.

2. *Method II.* (*a*) *and* (*b*).—Two parties, each composed of one officer and 20 men, were pitted against each other at the same entanglement. The one (*a*) was provided with ladders, planks, etc., etc., to build a road over it, and the other (*b*) with axes and wire cutters to clear a way through it.

In rather over ten minutes the first man of party (*a*) made a precarious descent on the enemy's side of the obstacle, the remainder then slowly straggling across the bridge, several falling into the wire on the way. The method seems little suited to prepare a path for assaulting columns in rear, without the bringing up of a quite prohibitive quantity of material.

The cutting party (*b*), on the other hand, made a clear road three bays (18 ft.) wide right through the entanglement in less than five minutes. This road, of course, remains open for troops in rear. These experiments were twice repeated with practically identical results. The method of cutting the wires with bullets (from rifles specially fitted with clips on the muzzles) was not tried, the requisite clips not being available. This would probably be still quicker; though a trifle dangerous to practise in peace time with more than one man at a time.

3. *Method II.* (*c*).—As to the best conduct of this operation there are a number of varying opinions, regarding (*a*) the weight of charge necessary per foot run of the obstacle to be cut, (*b*) the total length of the charge with reference to the width of the entanglement, (*c*) the best method of making up the charge, and (*d*) its position in, on, or under the wires. As these are extraordinarily contradictory, I have summarized them in the table shown on next page.

To test these various conflicting views, the following experiments were carried out, the entanglement being of exactly the same type as that mentioned previously:—

4. *Russian System* (*Z*).—Jointed plank 18 ft. long, charged with 224 2-oz. dynamite cartridges; or about 1¾ lbs. of explosive to the foot run; placed on the ground beneath the entanglement; fired by fuze and detonator in near end. In spite of a perfect detonation the result was a complete failure. The sole effect was the cutting of *two* wires (out of some 36 composing the width of the entanglement) and the scooping in the ground of a furrow about 4 in. deep.

5. *Russian System* (*Z*) *again.*—Same length of charge, but composed of 36 halves of 1½-lb. slabs of wet guncotton; or about 1½ lb. of explosive per foot run. Placed and fired exactly as before. Again a perfect detonation, and again a most disappointing result, though a little better than before in spite of the rather smaller charge. Eight wires were cut on this occasion, and the furrow in the ground was about 8 in. in depth.

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TABLE A.

Destruction of Wire Entanglements with Explosives.

Comparison of Previous Authorities.

Reference Letter.	Authority.	Charge per foot run.	Length of Charge with Reference to Width of Obstacle.	Method of making up Charge.	Method of placing Charge.	Remarks.
W	M.F.E., § 48 (ii.) a	2 lbs. foot run guncotton.	(Not stated).	Explosive lashed to a pole, or stuffed into canvas hose.	*Pushed* along the ground *under* the wires.	
X	*R.E. Journal*, February, 1912 (Ideas on Field Works).	Do.	Do.	Do.	*Thrown* across the *top* of the wires.	"Best results by Jar" are obtained by placing charge on top of the wires and not underneath.
Y	*R.E. Journal*, June, 1912 (French Transcript).	"Treble charge" melinite.	Length of charge to be *18" greater* than width to be cut.	Explosive stuffed into canvas tubes, each 15 metres long.	*Dragged* into position underneath the entanglement by men crawling under the wires.	States that a charge placed on *the top*, produces only half the effect of one placed in ground underneath.
Z	*R.E. Journal*, August, 1912 (Russian Transcript).	2½ lbs. pyroxiline per foot run.	Length of charge to be 3—4 ft. *less* than width of entanglement, to be cut.	Explosive lashed to planks 6 ft. long, arranged to join end to end and so make charge of any required length.	The front plank has small wheels and the whole charge is pushed along ground under the entanglement from near side.	

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The Russian system, therefore, in spite of the rather fascinating jointed plank with its wheeled head, must be considered a failure. In any case a defender who had the sense to dig a small trench all along the middle of his entanglement would utterly defeat any attempt to place the charge across its breadth in this manner. These two failures dispose also of the French system (Y), as in that also the charge is laid on the ground beneath the wires. Further, as in this case the charge is made up in canvas hose, it is subject to the additional disadvantage of having to be dragged into place by men crawling under the wires—not a very attractive manœuvre!

6. *R.E. Journal, February*, 1912 (*X*).—Charge of 1¾ lbs. of wet guncotton (a mixture of halves of 2-lb. and 1½-lb. slabs) tied along a spar and placed on the top of the entanglement. Charge of same length as width of obstacle—viz.: 18 ft. Result very fairly successful, all wires being cut except five, which were all low down by the ground.

7. *Experiment for Length of Charge.*—In all the preceding experiments the charge was made the same length as the width of the entanglement to be cut, and carefully placed with its extremities directly above (or below, as the case might be) the front and back edges of the obstacle. The last experiment was now repeated with a charge 1 ft. less in length than the width of the entanglement (*i.e.* 17 ft. as opposed to 18 ft.) to see if there was anything in the Russian theory that the length of explosive might be less than the width of entanglement to be destroyed. It was found that, although the ends of the charge were only 6 in. short of the front and back edges of the entanglement, ment, the four horizontal wires in each of these escaped.

From these results it may be deduced, I think, that the charge must be *at least* as long as the width of obstacle to be cut.

8. The results of a charge placed on the top of the wires having thus been so satisfactory, it might be thought that further experiments were unnecessary. This would be so were entanglements never made of greater width than 6 or 12 ft., as the loaded spar can fairly easily be thrown across this width. But with increasing breadth of obstacle, this manœuvre becomes more and more difficult, till it is pretty well out of the question for anything over 18 ft. wide. The operation of carrying up (probably under fire) an 18-ft. pole loaded with 36 lbs. of explosive, and then hurling it so that it will fall accurately across an 18-ft. wide obstacle might alarm even an expert tosser of the caber.

Also it is evident that a charge placed entirely above or entirely below its work must waste half its energy on the air or the ground, as the case may be. Why not, then, place the explosive *through the middle of the entanglement*, where it can get at its work in every direction? This should at least make for efficiency, and the idea of ramming the charge head first through the side of the entanglement about half way up suggests itself. Unfortunately, in the case of a rough pole covered with guncotton slabs or dynamite cartridges lashed on with twine or wire,

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the whole affair is bound to be brought up all standing, long ere it is across, by barbs and wires catching in its various crannies and protuberances. Also this lashing on of the explosive is at best a very tedious and unsatisfactory arrangement. Portions of high explosive require to be in close contact to ensure detonation, and however carefully this may have been arranged when the charge was first made up, it is more than probable that several gaps will have appeared by the time the long spar has been lugged across the fire-swept zone and hurled across the obstacle. Also, the mere lashing on of such a charge takes a considerable time.

The problem, then, is how to make up a charge, which :—

(*a*). Can be made up quickly in portable sections, which can be put together instantly to any required length at the site of the demolition.

(*b*). Will have so smooth an outer surface all over that it can be rammed head first into the middle of the entanglement, and slide over the wires without catching on them.

(*c*). Will not shake apart, whatever rough usage the sections get when in transit.

9. *Preliminary Experiment.*—To fulfil these conditions the use of an 18-ft. length of galvanized water pipe (which happened to be lying near the site of the experiments) suggested itself. True, it would not fulfil condition (*a*), but this could be arranged later. It promised to meet conditions (*b*) and (*c*) admirably.

Accordingly this pipe was plugged up at one end and 2-oz. dynamite cartridges dropped down it in packets of four at a time, being rammed at intervals with a bamboo, until it was full. It took 60 of these packets, or 30 lbs. of dynamite, which work out to about 1¾ lbs. to the foot run. (Note that this is the same charge which proved a complete failure with the Russian system). The loaded pipe was brought up by four men and rammed right through the middle of the entanglement with the greatest ease, being rested on the wires and slid across them. The charge was then fired by fuze and detonator fixed in the rear end.

A most violent explosion resulted, every wire in the three bays crossed by the pipe being destroyed, as well as about two-thirds of those in the bays adjoining on either side. Several of the 6-in. diameter posts were snapped off at the ground level, and others splintered. This part of the entanglement, in fact, was an entire wreck.

Satisfactory as this experiment was as regards the demolition, yet the pipe was rather too heavy and unwieldy for use in service conditions. Also, after the explosion the air was full of jagged bits of iron for quite a long time, some of them falling over a quarter of a mile away. Although this would not matter much in war, as these would be no more dangerous than the rifle bullets (of which there

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would probably also be a good many in the air during these operations), yet it is rather to be deprecated in peace time practice. So the following apparatus was designed to meet these two objections.

10. *The "Bangalore 'Torpedo.'"*—From the drawings (*vide Plate*) it will be seen that this is made in sections, the unit being a tin tube 6 ft. 6 in. in length, and of 2½-in. diameter; all the units are absolutely interchangeable. One end of this tube is closed with a flat bottom (S), like that of a jam tin. The other end (T) is open and fitted with an external sleeve or socket projecting another 8 in., into which (if desired) the closed (S) end of a similar tube can fit closely (*vide Fig.* 1). A number of such unit tubes can thus be fitted together to any required length (*vide Fig.* 2).

If dynamite cartridges (made up in packets of four abreast) are dropped into such a tube (which can be done very quickly), it will take 23 packets, or rather over 1¾ lbs. to the foot run. Its explosive length is now 6 ft. 6 in., and this can be increased to 13 ft., 19 ft. 6 in., and so on by fitting together as many of these unit tubes as may be required. The closed end (S) of each tube butts tightly up against the explosive at the open end (T) of its predecessor. If the system is then fired from the last end left open, the whole will detonate as the tin bottoms of the tubes offer no obstacle.

Obviously, such a "torpedo," composed of as many unit tubes as may be necessary to give the required length, having nothing on its smooth outer surface to catch on the barbed wire, can be run in any direction through the thickest and widest entanglement, sliding on and supported by the wires themselves.

11. *Ignition, etc.*—It has been stated that the 6-ft. 6-in. tin tube is the unit of the system. To each unit, however, two other accessories are provided, to facilitate transport, placing and firing. These are "The Live Handle" (C, *Figs.* 1 and 5), and "The Nose" (B, *Figs.* 1 and 3). The former is provided, firstly to close the open end (T) of the tube during movement and prevent the explosive falling out; and secondly, to contain the means of ignition of the charge. (For reasons which will be evident later, *every* unit tube is provided with independent means of ignition). This handle is just a rough piece of dealwood, about a foot long, and of diameter sufficient to fit fairly closely into the sleeve or socket on the (T) end of the tube. In one end of it a recess is hollowed out with a chisel (*Figs.* 4 and 5), large enough to contain a single dynamite cartridge, with fuze and detonator in place, the latter being carried to the outside through a groove in the wood. The other end of this cartridge, therefore, when the handle is in place, will press against the top of the explosive in the tube, and so serve to detonate it when itself fired by the fuze. A removable safety pin (large nail, or stiff piece of wire) which runs crosswise through the handle and socket, prevents the former from falling out during movement.

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— THE BANGALORE "TORPEDO." —

FOR DESTROYING WIRE-ENTANGLEMENTS.

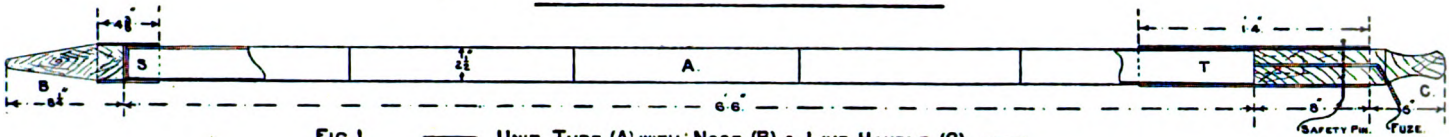


FIG. 1. — UNIT TUBE (A), WITH NOSE (B), & LIVE HANDLE (C) — IN PLACE.

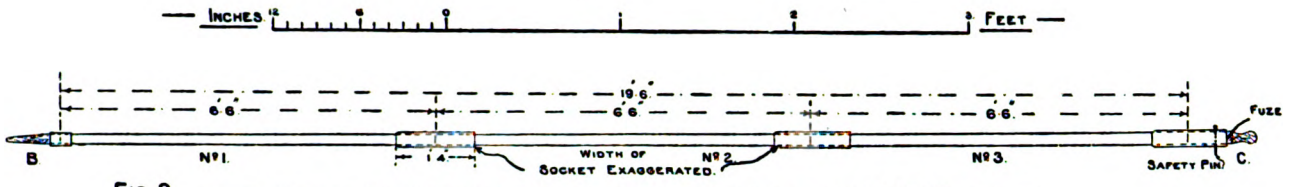


FIG 2. — TORPEDO COMPLETE FOR DESTRUCTION OF ENTANGLEMENT 18 FT WIDE

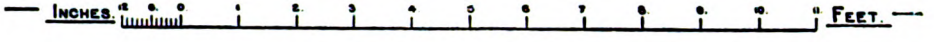


FIG. 3. — SECTION OF NOSE.

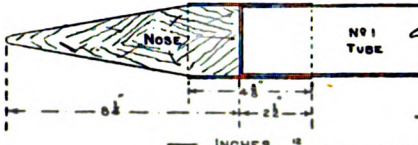
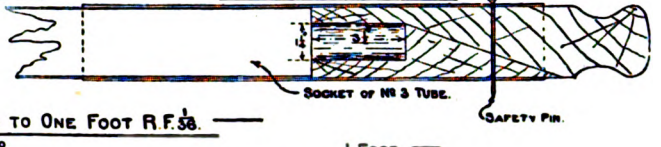
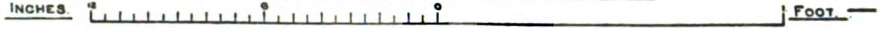


FIG. 4. — PLAN OF LIVE HANDLE.

FIG. 5. — SECTION LIVE HANDLE.



SCALE 3 INCHES TO ONE FOOT R.F. $\frac{1}{38}$.



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The "Nose" (*Fig.* 3) is a cone-shaped piece of wood fixed in the end of a tin socket a few inches in length, and just wide enough to fit over the (S) end of a unit tube. When thus fitted, the "Nose" enables the front end of the "torpedo" to force its way through the intricacies of a thick entanglement with greater ease than would the flat end of the unit tube. It can be pulled off and discarded in a moment. The weight of one unit tube (empty) with handle and nose is about 8½ lbs., when made of block tin.

12. *Method of Placing the "Torpedo"* (*Photo* 1).—Each man of the demolition party sets out armed with one unit tube, with the live handle fixed in one end, and the nose fitted over the other. The total weight of such an unit tube (loaded with 1¾ lbs. dynamite per foot run) is just over 21 lbs., an easy burden. On arriving at the obstacle its width will be seen; it is unlikely to be ascertained previously by any form of reconnaissance. Should it be no more than (say) 6 ft. wide, all that is necessary is to ram as many unit tubes as possible *individually* through it, light the fuzes and await results; each tube is complete in itself with its own means of ignition ready for use. If, however, the entanglement proves to be (say) 18 ft. in width, the first man up rests the nose of his tube on the wires at a convenient height and rams it in up to the socket, pulls out his handle and discards it. The next man pulls off and discards his "nose," fits the (S) end of his tube into the socket of No. 1, pushes forward the (now) 13 ft. long torpedo into the entanglement again up to the socket, and likewise discards his handle. Similarly, No. 3 throws away his "nose," inserts his tube into the socket of No. 2, and shoves the (now) 19 ft. 6 in. of torpedo right through the obstacle (*vide Photo* 2). The head of this last tube is left in, the fuze ignited, and the whole torpedo thereby detonated.

13. *Result.*—The accompanying *Photo* No. 1 shows the three unit tubes separately; No. 2, the complete torpedo formed by them in position in the middle of an 18 ft. wide entanglement; and No. 3, the result of firing it. As can be seen, this was entirely successful, every wire across the whole width of the obstacle being cut, and an absolutely clear passage left. The tin envelope was apparently pulverized by the explosion, and no pieces of any sort were thrown about. The assaulting party might have waited in perfect safety within 100 yards of the explosion.

14. *Conclusions.*—From the foregoing experiments the following conclusions may be drawn:—

(1). That 1¾ lbs. of explosive per foot run, placed *under* the wires on the Russian or French systems, is a failure.

(2). That the same charge laid *on the top* of the wires on the English system is considerably better, but very difficult to make up, carry, and place for wide entanglements.

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(3). That the same charge when *run through the centre* of the entanglement is most effective, and when made up on the "Bangalore Torpedo" system is both quick to load, and easy to carry up and place.

(4). Whatever system is adopted, the length of the charge must not be less than the width of entanglement to be cut.

15. *Materials Required for the "Bangalore Torpedo."*—The tin used to make the tubes should be preferably block-tin sheets, if procurable, as such tubes will stand a lot of rough handling. Failing this, however, the ordinary kerosene oil tin, the ration biscuit tin, or the S.A.A. box lining will do very well. Three kerosene oil tins are required for each unit tube, and an ordinary tinsmith can turn them out with ease and celerity. In the above experiments the tubes were made of kerosene oil tins. Table B gives, from actual experiment, full details of time, labour, cost, and material in the production of these tubes.

16. *Use of Other Explosives.*—The unit tubes are made 2½ in. in diameter as it is found that this size will take either four 2-oz. dynamite cartridges abreast (about 1¾ lbs. to the foot run), or exactly 2 lbs. to the foot run of wet guncotton slabs crumbled up and rammed into the tube. When guncotton is used, a 1-oz. dry primer should replace the dynamite cartridge forming the means of ignition in the handle.

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TABLE B.

DETAILS OF TIME AND MATERIAL REQUIRED IN THE MANUFACTURE OF THREE 6′ 6″ SECTIONS, MAKING UP A BANGALORE "TORPEDO" 19′ 6″ LONG.

Details.		Hours Work for One Man.	Dimensions. L. in.	B. in	T. in.	No.	Quantity. lbs.	ozs.	Unit.	Rate. Rs.	as.	ps.	Amount. Rs.	as.	ps.	Results.
Carpenters' Work.																TIME.
Labour	Making handles, and cutting same to receive detonator cartridge and fuze and fitting to tube with securing pin. Making noses.	8	—	—	—	sets 3	—	—	per 8 hours.	—	4	—	—	4	—	*Carpenters' Work.* 8 "man hours."
Material	Dealwood for handles, 3	—	15	3	3	3	—	—	per cub. foot.	3	—	—	—	12	—	
	Teakwood for noses, 3	—	10	3	3	3	—	—		3	8	—	—	9	4	
Tinsmiths' Work.																
Labour	Making tube, one end closed, and fixing connecting socket other end. Fixing socket to nose for connecting same to tube, and making wire pins for securing handle to tube.	18	—	—	—	sets 3	—	—	per 8 hours.	—	6	—	—	13	6	*Tinsmiths Work.* 18 "man hours."
Material	Tinsheets, double, 20″ × 14″, for tube, etc.	—	20	14	—	12	—	—	each	—	7	3	5	7	—	
	Solder for tube, etc.	—	—	—	—	—	1	2	per lb.	1	3	—	1	6	6	
	Fluxite for soldering	—	—	—	—	—	—	—	—	—	—	—	—	1	—	
	Tacks for fixing nose to tin band.	—	—	—	—	-	—	—	—	—	—	—	—	—	3	COST.
	Wire for pins securing handles to tube.	—	—	—	—	—	—	—	—	—	—	—	—	—	3	Rs. 9. 5. 10.
												Total	9	5	10	

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THE DISPOSAL OF SEWAGE FROM BARRACKS AND CANTONMENTS.

By Capt. M. G. Taylor, R.E.

Introduction.

The question of the disposal of the sewage of barracks is one which crops up periodically and becomes very serious when new barracks are built in the open country. Usually in such a case a civil sewer system is not within reach, and some method suited to the exigencies of the case must be adopted to dispose of the sewage. An attempt has therefore been made, in this paper, to summarize the various methods which have been adopted by towns to deal with their sewage, and to deduce from the varying success attending their efforts, how modern practice can be applied to the special case of barracks.

The theoretical aspect of bacteriology, as far as it concerns this subject, has perhaps monopolized rather a large proportion of this paper. It is, however, considered that, as the making of a suitable design of sewage works depends so largely on the application of first principles to every individual case, too important a place can hardly be given to bacteriology, which is the backbone of the whole subject.

Statistics have been as far as possible avoided. Figures are available for nearly all points which must be considered, but they are proverbially misleading, and as a rule convey but little real information. Some practical hints for the design of works are given. These are the essence of the experience of many practical civil engineers, who have given years to the satisfactory solution of the problem of the disposal of sewage, and good results can hardly fail to be obtained if they are applied to our special case of barracks.

The aim of this paper is to prove that sewage can be disposed of effectively and cheaply nearly everywhere, but that a method which gives good results in one place is not suitable in another.

"Sewage" may be taken to comprise a certain portion of the refuse of a community. "Refuse" generally consists of a large number and variety of articles of which the following are representative :—ashes, cinders, breeze, rubbish, soil, filth of all sorts, refuse from trades and

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factories, dust, mud, road scrapings, ice and snow from streets; all these things have been found in the refuse of one single town, and those of them which are carried through sewers by water form "sewage."

An analysis of such sewage, which is an average town sewage, would give approximately the following figures:—

Out of every 100,000 parts of raw sewage

Solids in suspension	44·6	
Solids in solution...	72·3	
Total solids		116·9
Chlorine	10·6	
Ammonia (free or in salts)	6·7	
Organic or "albumenoid" ammonia	1·8	

By far the most noxious of the constituents are the organic matters, both in suspension (forming half the total), and in solution. If sewage containing organic impurities in considerable proportions be discharged direct into a stream or river, pollution of that stream is a certainty, and such pollution would be a grave source of danger to all animal forms of life near or in the stream. Since, however, it is clear that the sewage of a community must be got rid of, it follows that before ultimate disposal it must be purified to such a degree that the danger of pollution is minimized. Compare the following figures taken from a fair sample of effluent after treatment with those given above for raw sewage:—

Out of every 100,000 parts of effluent

Total solids	88·3
Chlorine	10·5
Ammonia (free or in salts)	1·5
Organic ammonia	·15

It is evident that nearly all the organic matter has disappeared, and that therefore the impurities which are objectionable have mostly gone. This effluent would be practically safe to discharge into any moderately-sized water course unless it contains some poison in inorganic chemical form; as this form of impurity is always due to the discharge from chemical works and certain trades, which are not likely to be present in barracks, it need not be considered here.

If the sewage of barracks or cantonments can be purified to the extent shown by these figures without too great a cost, it is well worth while, in the interests of the health of troops, trying to adapt some method and to deal with the matter on a small scale, even as the large towns are now dealing with it on a large scale to improve the health of their populations.

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Whatever may be the particular method adopted, the underlying principle of the disposal of all sewage is the action of bacteria. Certain other agencies, higher forms of life than bacteria, such as worms and "podura," have also their particular functions in the destruction of putrescent matter, but the chief and final agencies are bacteria. In order to understand how these agencies effect their work, it must first be explained that bacteria are of infinite variety. They are minute living organisms multiplying at an enormous rate in favourable conditions, dying at an equally high death rate under adverse circumstances. Some are disease germs, others not only harmless but absolutely necessary and beneficent to higher forms of life, and these latter form by far the greater number now known. Bacteriology is still in a very imperfect state, but it is already made fairly evident that many reactions of an organic nature, which a few years ago were considered to be purely chemical, are in reality due to bacteria. Bacteria are exceedingly minute. From observations it has been computed that somewhere about 7,000,000 exist in one cubic centimetre of London sewage collected at Barking. This same sewage after treatment is found to contain less than 1,000th part of that number, and of those still present very few are harmful. As far as sewage disposal is concerned, the bacteria engaged in the task of purification divide themselves apparently into two main classes, to which the name of "Anaerobes" and "Aerobes" have been given. "Anaerobes" exist without air, and work best where air has no free access. "Aerobes" on the contrary require air and die if deprived too long of it. Anaerobes and aerobes can work together under identical conditions for a time, but as the natural conditions for each class are so antagonistic, one class will eventually survive to the exclusion of most of the other, and the result will not be satisfactory. Both aerobes and anaerobes exist everywhere, and it is not only in sewage but throughout the whole surface of the land that the effect of their work is visible, as, for example, the destruction and assimilation with the soil every autumn of fallen leaves.

Anaerobes work by putrefaction, aerobes by oxidation of the products of anaerobes, but there are again other bacteria which are neither anaerobes nor yet aerobes, but are midway between. The action of these continues whether there be air available or not, and they possess to a slight degree in themselves, both the power of putrefaction and that of oxidation. These "Facultative Bacteria," as they are called, are not very numerous, and do not carry out a large proportion of the work to be done. Their existence is interesting, however, mainly as explaining how nature arranges for the disposal of sewage under conditions which on the face of it appear unsuited to the continued existence of either aerobes or anaerobes.

Practically all organic matter is composed of hydrogen, carbon,

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oxygen, and nitrogen, and the work of bacteria in disposing of sewage has been summed up as follows :—"The nitrogenous matters are resolved with either the production of ammonia, the oxides of nitrogen, or possibly the evolution of uncombined nitrogen. The oxygen and hydrogen . . . are recombined into water and the carbon becomes carbon dioxide . . ." This explains how it is that the sewage after bacterial treatment is so harmless, consisting as it does of merely inorganic compounds and elements.

Anaerobic action has the great power of clarification by liquefying the solid organic impurities which are held in suspension. Thus if the sewage be treated by anaerobes alone after the inorganic solids in suspension have been removed by some mechanical means, the resulting effluent is quite clear ; but since anaerobes work by putrefaction, the effluent is highly obnoxious. Further treatment by aerobes oxidizes the obnoxious matter, and hence the effluent resulting from the double treatment is, to a large degree, pure and harmless.

The methods in use at the present day, which are practical applications of the bacterial theory, are :—

(*a*). *Clarification.*

Mechanical Process	Screening.
	Sedimentation.
	Precipitation.
Anaerobic Process	Liquefying or Septic Tank.

(*b*). *Oxidation.*

Aerobic Processes	Broad Irrigation.
	Land Filtration.
	Contact Beds.
	Percolating Filters.

Each of the two main stages, viz. : Clarification and Oxidation may be effected by any of the four distinct processes in each stage, but it is usually found that the best results are attained by works which contain a combination of processes best suited to local requirements. For example, it used to be considered that where towns were situated on the coast, the mere discharge of the raw sewage into the sea at a sufficient distance from the foreshore was all that was required, and this is still done at Aberdeen where circumstances are more favourable than usual. It was found however in most such cases that, while parts of the sewage floated and other parts sank, the former, by reason of the tide, fouled the foreshore, and the latter formed mud banks, which when uncovered at low tide became offensive. Fish, too, abandoned the locality,

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spoiling the livelihood of local fishermen. The idea therefore of discharging raw sewage into the sea must as a rule be abandoned. This is especially the case for coast barracks where the men are in the habit after work, of wandering on the beach and picking up shell fish. Similarly, riparian owners soon object to the discharge of raw sewage into rivers, and this, as a matter of fact, is now made illegal. The question assumes a very serious aspect when neither sea nor large rivers are available, and where resort must be had to soakage into the land.

Of the clarifying process enumerated :—

Screening consists in passing the sewage through a strainer formed by iron bars, woven wire screens, or perforated metal in order to remove all coarse floating débris. Screens must be continually raked clean and the débris burnt or treated with the ordinary refuse.

Sedimentation consists in allowing sewage to stand in a tank undisturbed. The heavier solids in suspension will sink by reason of their greater specific gravity, and can be eventually cleared away from the tank bottom. The specific gravity of the majority of these solids is nearly equal to that of the sewage, hence the process is very slow and is now generally only used to remove road débris. The mud which forms is chiefly inorganic and therefore is not very offensive.

Precipitation consists in adding to the sewage, collected in a tank, chemicals which form a heavy precipitate with water, such as lime-water and persulphate of iron. The precipitate falling to the bottom entangles and carries with it most of the finely divided particles of solids held in suspension. Precipitation will clarify to a greater degree than plain sedimentation, and it acts faster, but the process has the disadvantage of increasing the bulk of mud, or "sludge" as it is called, by the large amount of precipitate formed. The disposal of the sludge can usually be effected by burying, or it can be used as manure for which it has a certain value.

Liquefying or *Septic Treatment* is now generally accepted to be the best of the clarifying processes, and consists in the anaerobic treatment of sewage in a tank, whereby the organic solids in suspension and *also in solution* are broken down by the action of anaerobes. A quantity of gas is liberated by this action, which, rising to the surface, stirs up the sludge and puts an end to sedimentation. The effluent from a septic tank is offensive, but the sludge is practically *nil*, and what there is, is entirely inorganic and presents no difficulty as to disposal.

The following are the oxidation processes, which are applied to the effluent under treatment by one or other of the clarifying processes :—

Broad Irrigation, sometimes called *Surface Irrigation*, which consists

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in applying the effluent sewage to the surface of suitable land upon which crops of rye or roots are grown simultaneously with the applications of the sewage. The idea being that the aerobes in the surface soil oxidize the sewage, which is thereby rendered suitable for assimilation by the crops. The land for this system of treatment requires a good deal of preparation, and since it is only possible to discharge the sewage whilst the crops are actually growing, the process can only be carried on during a limited portion of the year. A light alluvial soil, which is fairly porous, is the best land for broad irrigation, and in order to drain the subsoil water away so that the sewage may thoroughly soak in, and so that the aerobes may get plenty of air, a rather complete system of underdraining by agricultural pipes is usually necessary. The cost of this system, combined with the fact that a large area of land per head of the community drained is required, makes it rarely possible to use this system for barracks.

Land Filtration is a system whereby an area of light sandy land is flooded intermittently with the effluent, which soaks through and is oxidized in the process, being drained away as a final effluent by a system of underdrains. The essential difference between "Filtration" and "Irrigation" lies in the growing of crops, and in the fact that the former may be used on land which is too light to support vegetable life. If the soil is very light and porous, and the sewage dose be well distributed, the land will usually be able to receive a dose every two days, and it is allowed to dry and become aerated between each dose. This necessity of quick drying makes it imperative to be able to carry off the final effluent quickly, so that a more complete system of underdrainage is required for filtration than for irrigation, with a proportionate increase in cost per unit of area, though the total area required for a given quantity of effluent is not so great. Like irrigation, this is a system that can rarely be applied to barracks, although local considerations may make it a possible solution.

Contact Beds are artificial bacterial beds. The process is, in principle, that of land filtration, but a medium is provided and conditions generally arranged to encourage the multiplication of aerobes. The bed is formed into a tank, and the effluent is quickly run in and allowed to rest for a period long enough for the aerobes to do their work of oxidation. It is then quickly run off, and while it drains away through the media it draws air in to aerate the bed. When empty the bed is allowed to stand so for as long as possible, to complete the work of aeration. It will be noted that while a dose of sewage is being treated, and the tank is full, the aerobe is actually working under anaerobic conditions. For a limited space of time the aerobe does not seem to object to this, but it is most essential to thoroughly aerate the bed after a treatment, otherwise the aerobes would most certainly suffer. It is found that if a tank rests full for about four

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hours, the work of purification will then be complete, and it is usual to arrange contact beds in such a manner that they will receive one dose of four hours duration per diem, and that aeration shall continue for the remainder of the twenty-four hours (after deducting the time occupied in filling and emptying, which is practically time wasted). It is not advantageous to give a longer period of aeration than this, for the reason that food is as essential to the aerobe as air, and lack of sewage means starvation, with a consequent deterioration in the efficiency of the contact bed.

Percolating Filters are similar in most respects to contact beds, but differ in the methods of operation. They consist essentially of a tank filled with a medium and arranged with an underdrainage system to take away the final effluent. The sewage is slowly and most carefully distributed over the whole surface of the filter, and is allowed to percolate past the media continuously, and drawn off as it collects in the underdrains. In this way the filter is constantly aerated, so that the aerobes are working under conditions more favourable to them than is the case in contact beds. The distribution is, however, very important to their efficient working, and many mechanical devices are on the market to ensure this. Some of these distributors are worked by the fall of the sewage itself, either as a "Barker's Mill," or water wheel, and some by exterior power. For large filters, the choice of distributor presents difficulties, but for small tanks distribution is adequately secured by means of some such device as the "Stoddart" distributor. This consists of corrugated iron sheets covering the media, perforated in the upper edge of the corrugations, and having nails let in at the bottom edge at equal intervals from the points of which the sewage can drip. In connection with this problem of distribution, it has been found that the path of a liquid, percolating through a fine medium-like sand, is not vertically down from the point of application, but follows a parabolic path and so tends to distribute itself laterally as it falls. In small tanks, such as those for a barracks, efficient distribution would therefore be secured by running the sewage on to the media by means of distribution shoots, taking care that not more than two-thirds of the surface of the filter is covered at one time. The media must be fine for a depth of a few inches from the surface. Even better results may be secured if the sewage is shot on in small intermittent flushes, by means of an automatic tipping bucket, or by syphons like those in the usual flushing cistern of a water closet.

As regards the medium itself, the following considerations govern the choice of material most suitable for use. As the aerobic conditions require plentiful aeration, and as the effluent treated is only that portion in contact with aerobic organisms, and further as the growth and strength of the aerobic colonies depend on the quality

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and area of the surface of the medium, it follows that medium must :—

(1). Have plentiful interstices for the admission of air.
(2). Present a roughish surface for aerobic foothold.
(3). Present as large a surface as possible.

Media must therefore be of some strong hard insoluble material, not liable to disintegration into dust, nor liable to "pack" into a solid mass. The individual pieces should approximate to a cube in shape. The following materials have been used with varying success, and many other similar materials are available in various parts of the world, which would doubtless give equally good results.

(1). Burnt clay—not very good.
(2). Coal—rather dusty but has the curious property of producing a good effluent from the commencement of action, while all other media require maturing. It is usually too soft.
(3). Coke—too light, and is liable to shift by flotation. This movement causes grinding, and dust in formed.
(4). Gravel—well washed and screened gives fair results, but is rather smooth of surface.
(5). Slag—if carefully selected gives good results, but no traces of sulphur or lime must be present, or the material soon disintegrates.
(6). Sandstones—are too soft and dusty.
(7). Granite--carefully washed free from clay and dust is excellent. Flat dressings from large blocks are not good.
(8). Furnace clinker—excellent, if of the hardest quality. It should not weigh much under 18 cwt. per yard cube. Lighter clinker is too soft.
(9). Saggars, or broken crocks—very hard, and give excellent results.

In filling contact beds and filters, care must be taken to grade the media so that the largest material is at the bottom and the finest at the top. As a rule good effluents are obtained from media $\frac{1}{2}$ in. to 1 in. cubes at the bottom, and grading to $\frac{1}{8}$ in. to $\frac{1}{2}$ in. at the top.

Having considered the various methods in use at the present day, the next matter is to run through the principles which govern the size of any proposed sewage disposal works.

The most important factors are the volume and composition of the sewage. As to the volume, the whole matter depends on :—

(*a*). Whether storm water is discharged into the sewer system, or by separate sewers.
(*b*). Whether there is an unlimited water supply to the area drained.
(*c*). The number of the population served.

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In towns, storm water is as a rule discharged into the sewers, because the matter brought down from back yards, roofs, streets where there is much horse traffic, cabstands, and so forth, is usually as foul as ordinary sewage during the early stages of rainfall. Besides this, a certain section of the population is not cleanly in its habits. In barracks, however, cleanly habits in yards and cookhouses are enforced, and there is little horse traffic, so that the storm water is not so foul. Where the disposal of barrack sewage is to be a matter for the military authorities to undertake, it would appear advisable to have a separate system of sewers for storm water, and to treat the discharge from these at the outfall as being pure. It is evident that if this course be not adopted, the quantity of sewage which must be treated at the disposal works will be greatly increased, and to cope with the possibility of heavy rainfall, the works must be much larger and consequently more costly. It is, as a matter of fact, calculated that a rainfall of $\frac{1}{30}$ in. per hour will, if the population is of average density, multiply the usual sewage flow by 5. It is easy therefore to see what heavy work the sewage works are subjected to by a bad rainstorm. Now since sewage is brought down by water, it will in volume bear some relation to the water consumption, as practically all water used eventually goes to the sewer outfall. In barracks this will probably be from 15 to 25 gallons per head, and from this the approximate quantity of sewage to be expected is readily calculable, and a figure is arrived at which is called the "dry weather flow." Now this figure is the unit upon which all the calculations as to size for the disposal works must be based, and it is usual to allow for twice the dry weather flow. If it is proposed to use existing sewers, which may be old and leaky, the dry weather flow may be increased by as much as 50 per cent. by the leakage into the sewers of the subsoil water, and allowance for this extra volume must be duly made.

As to the composition of the sewage, a small number of gallons per head means a strong sewage, and short sewers mean fresh sewage, so that it may be assumed that barrack sewage will be strong and fresh, and consequently very offensive. This will affect the choice of site, but not necessarily the choice of method.

The choice of method to be adopted, for any particular barracks, is so affected by local considerations, that it is quite impossible to definitely say which would give the best results. If the barracks are by the sea, or by a large and rapid river, it may be sufficient to clarify by sedimentation, or possibly by septic treatment, and then to run the effluent without further treatment into the sea or river, having first made careful observations of the currents, but this will depend on whether the foreshore or banks are thickly populated. It is never good to discharge a foul effluent on the flood tide, but

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a storage tank should be provided and the whole discharged between first and half ebb. Land treatment may be possible abroad, where large areas of thinly populated land of a suitable character are handy, while if the level of subsoil water be of a good depth and there is no danger of well pollution, it may not even be necessary to underdrain. Undoubtedly the most complete and satisfactory way, where existing sewer systems are not available and where barracks are badly situated for land treatment or sea disposal, is by a septic tank and percolating filter, provided good media can be obtained locally. After treatment in this way the effluent is quite harmless, and can be discharged into any small water course, or even by mere soakage in the open country. The following formulæ and rules should be observed when designing the works :—

(i.). Allow 16 hours tank treatment for all sewage in septic tanks.

(ii.). Draw off the septic effluent a few inches below the surface by means of a floating arm arrangement, so as to leave undisturbed the scum which forms.

(iii.). Arrange baffle plates to check the flow through the septic tanks.

(iv.). The floor of the septic tank must have a fall to a sump pit to collect the sludge.

(v.). Divide the septic tank into longitudinal compartments to facilitate cleaning.

(vi.). For percolating filters allow 1 yard cube per head of population. Pay great attention to distribution.

(vii.). Make filters shallow, from 6 ft. to 7 ft., if the area is available, in order to ensure thorough aeration.

(viii.). Divide the whole area of filter required into several small filters so as to allow all filters to be worked at a uniform rate, and to make provision for resting an overworked filter.

(ix.). If possible subdivide each filter in order to admit of screening and washing the media of any section, if it becomes clogged.

(x.). Always provide a small detritus tank where the raw sewage may be screened, and the heavier materials in suspension may be deposited.

(xi.). Provide ground where the sludge from the detritus and septic tanks may be buried in shallow trenches. Deep trenches are useless as aerobic action in ordinary soil usually ceases at a greater depth than 4 ft. 6 in.

The whole subject is of so vast a scope, and covers so much ground that it is impossible to give more than the general principles, which in every case must be applied in the manner best suited to local requirements. Types could of course be given, but to give a type of sewage works with the idea of reduplicating wherever

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required is quite useless. Many bacterial works are now in existence, and much could be learnt by visiting them, but no good can come of slavishly copying them on a smaller scale for barracks, and, if this course were attempted, failure would be the result in the majority of cases. However a diagram plan and section is attached (see next page), showing works similar to those that might be required for a barracks for two battalions, and which were actually constructed at the Naval Barracks, Shotley, Essex, for a garrison of 2,000. The diagram is not given as a type, but it shows a convenient arrangement of a septic tank and percolating filter installation, on a small scale. The works in question have given every satisfaction.

Reference Books.

"The Design and Construction and Maintenance of Sewage Disposal Works," by Hugh P. Raikes. 1908. (Archibald Constable & Co., Ltd., 10, Orange Street, W.C.).

"Some Principles underlying the Design of Small Sewage Installations," by Gilbert J. Fowler, D.SC. (A Paper before the Edinburgh Architectural Association: 27th March, 1907). Price 1s. 6d.

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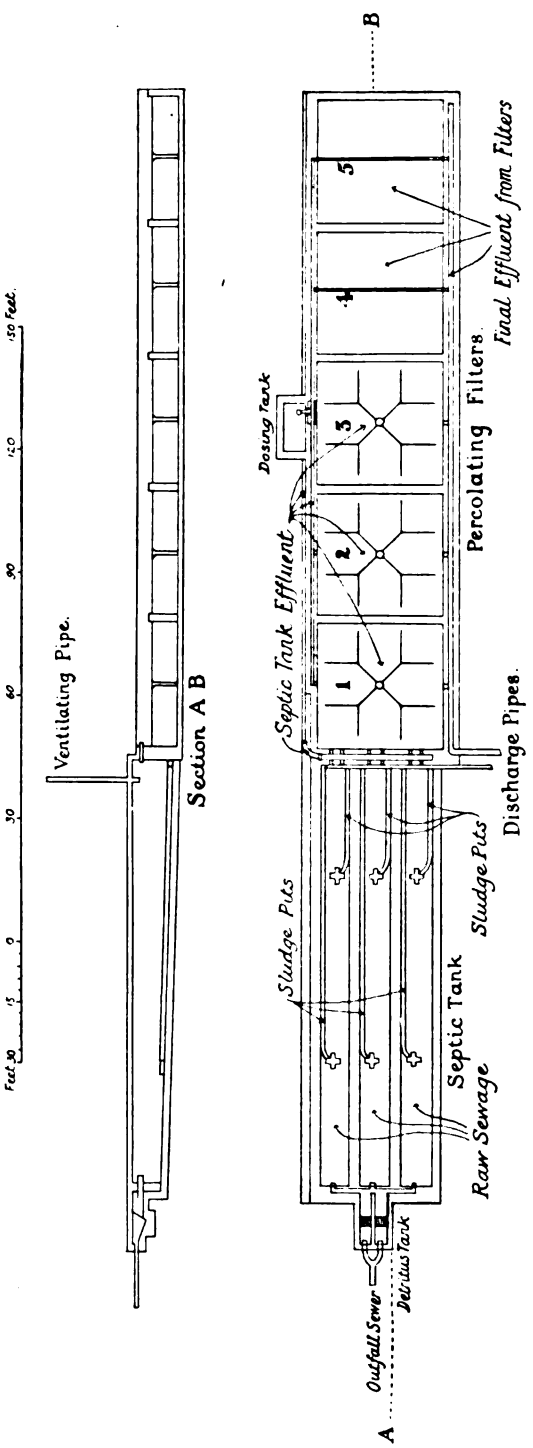
DISPOSAL WORKS AT NAVAL BARRACKS, SHOTLEY, ESSEX.

(For 2,000 Persons).



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THE DIARY OF TWO NOVICES IN NYASALAND.

(*Concluded*).

By Lieut. J. Benskin, R.E.

Saturday, 1st October.—A long long day was spent walking after the old spearman's spoor, which when picked up turned out to be quite 30 hours old. With the usual native politeness, the immediate desire to give pleasure had induced the old fellow to consistently lie. We lunched somewhere near Chelinda, wandered on to somewhere close to our first day's adventures with elephant, and only reached camp in the dark, completely done up ; however, on finding that the boys had in our absence built us two neat little grass shelters as a bath room and a kitchen we cheered up again, and began to organize proper search parties amongst the boys for the next day's work.

Sunday and Monday, 2nd and 3rd October.—Fish was still fit to go on for another walk and went off with his own boys, but I was badly in need of a rest and spent a lazy day making the Tenga-Tenga clean up our gear and cut our hippo hide into decent whips. I also had the tails of the few beasts which we had killed mounted on hard wood handles, and spent a happy hour or two in my pyjamas and bath slippers directing Littlejohn in his efforts to catch me butterflies. Littlejohn had improved, and no longer used to bring me a handful of wingless butterfly corpses and then stand waiting to see me eat them, and by then knew that I was merely a madman who would only keep a butterfly if it were pretty. Even a butterfly had been to his mind only another form of Nyama—game, meat or flesh.

Just before Fish returned at mid-day we had a visitor, the nearest chieftain and rather a famous person, being the son of that Makanjira who had given so much trouble in the rebellion days. He seemed a gloomy man and actually refrained from bringing a present on that his first visit to us, but having an eye for the future he offered to send out his best boys to definitely locate any big elephants in the district.

Fish had just cleaned himself and was also feeling comfortable in his pyjamas when another visitor arrived—a runner in hot haste this time. At a village named Ligwena, close to Chelinda, three big bulls had spent the previous night trampling down the native lands. Undoubtedly they were still there, said the messenger, for the chief had heard of our presence and had forbidden anyone to remove the elephants.

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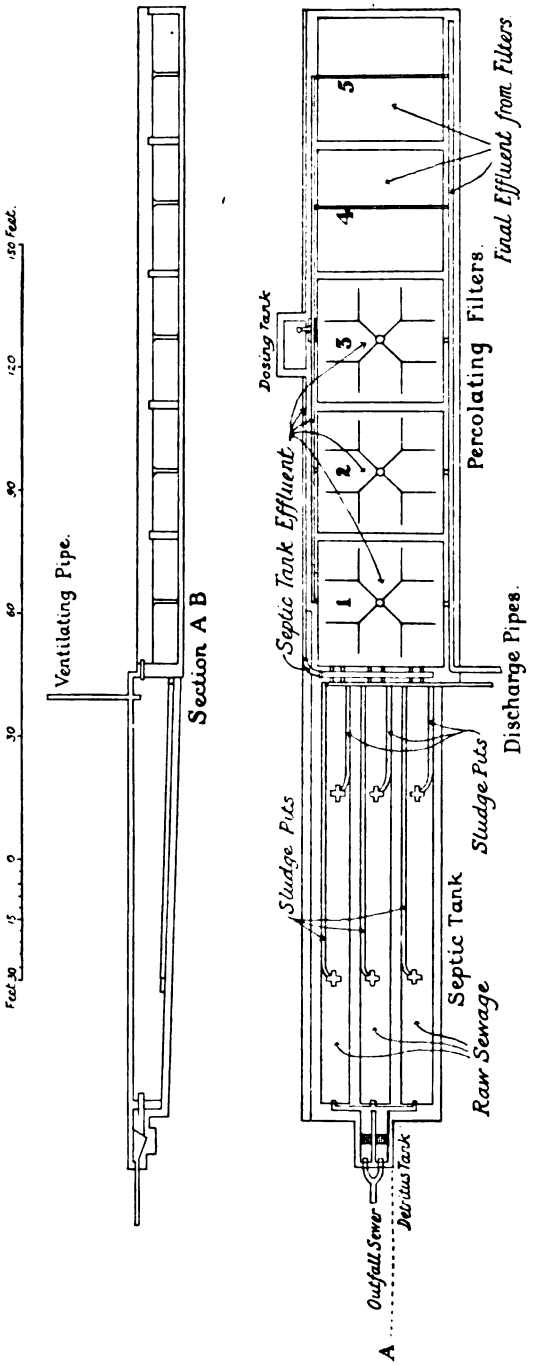
DISPOSAL WORKS AT NAVAL BARRACKS, SHOTLEY, ESSEX.

(For 2,020 Persons).



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Within 10 minutes we had our gun bearers and water carriers with John and the old man cantering off to Ligwena, and were ourselves soon following on the jingas, our hearts bursting with renewed hope. Ligwena's chieftain was unlike the son of Makanjira ; for he proved to be a fat and cheery old gentleman, courteous and wreathed in smiles ; " Of course the elephant still were there " and then we gradually understood how at six o'clock the previous night three bulls had indeed been in the village mealie lands—the spoor proved it—and also how the entire village had shrieked, waved torches and beaten tom toms at one edge of those crops for many hours of the night. No one had seen the elephants depart, and needless to say no one had been into that thick bush on the other side to see—of course they were still there.

As usual we followed the spoor. By 5.30 Fish, who had been out all that morning, was finished, leaving me to carry on alone, for I instinctively felt that the elephant would be caught up somewhere. After going back to Ligwena for his bicycle, he only succeeded, as I subsequently heard, in reaching camp at all by the aid of burning torches.

As the dusk fell we halted and got ready to spend the night upon the trail. Wood was collected to make a fire, and the four boys and myself lay round it in a circle ate a little food and were ready for sleep. That night alone under the trees and away from even the civilization of a tent can never be forgotten. For hours one heard the soft murmur of the natives' voices, until only a gentle rustle or the strange cry of some creature broke the silence, and for the first time came the real call of the bush of great solitary Africa where only a black man can be companion. With nothing on but a cotton shirt and cut-down khaki trousers and a short British warm coat wrapped round one it was very cold, but somehow it did not matter and a sympathetic understanding taught one to gaze silently like a native for endless time into the flickering light of the wood fire.

At early dawn we were on the move after a run round to make the body fit, and after being led for about an hour towards the lake found the old spoor crossed by the same bulls' tracks fresh from their wanderings of that very morning. Elephant almost always rest during the midday heat and we felt certain of catching them up, but the meeting came earlier than was expected for at 8 o'clock we came upon quite warm dung and once more heard and smelt the animals. John was made to carry my little gun and the two of us began to creep up to where the bulls were hidden, leaving Simbota and the old man nearly weeping with distress behind.

Then John went completely mad ; the wretched nigger began to shake with frenzy and rapidly crawling forward with a silence which I could not hope to copy, quickly left me quite 8 yards behind. I did not dare to speak and was inwardly bursting with rage when he

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Buffalo killed near Nabwasi (now in the R.E. Mess).

Lion killed by Capt. Herring, R.E.

John.

Our one Elephant. Killed at Fort Maguire.

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The combined bag.

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suddenly swung to his right and pointed with my shaking rifle right up into the tree branches. It was indeed a frightening sight when I got beside him, for less than 20 yards off and down a widening broken-down patch, but 6 ft. wide at its entrance stood a huge bull motionless with upraised trunk directly facing and looking straight at John. His tusks were worn and yellow and very thick, of weight well over 50 lbs., quite a big elephant in fact for little Nyasaland where one does not get the heavy ivory of countries further north. Just behind the bull there was a big baobab and under it still leisurely fanning themselves were two other smaller bulls one of which I noticed had only one tusk.

John was positively shuddering with excitement, and could just hiss at me to "Shoot, Bwana, shoot. He charge!" But I did not dare to, felt unsure of the frontal shot, and fearing that every second the native might fire I very very slowly seized his right arm and dragged him after me to behind the bushes and crept a few yards to the right from where I hoped to get a certain side shot at the brain. In a few seconds a good spot had been reached, and the rifle was just being raised, when the bull made a half charge and I snapped at his brain. With a crash he fell sideways and was up again bolting away; again I fired straight at his tail and again he fell forwards, rose and disappeared into the trees.

Then there took place one of those incidents which always seem to occur with every sportsman at any critical moment, the rifle jammed and in no way could the breach be closed. The moment did seem rather critical as the other two bulls made a complete circle all round us smashing through the small trees and I expected them on top of us every moment. What need to say that John had emptied the Mannlicher, at the one-tusked bull he afterwards said and because he mistrusted its single tusk, but more probably into the air. Whilst still trying to close the breach—some sand must have got between the bore and the rim of the cartridge, the rifle never failed at any other time, I found the old man leisurely offering me the two empty brass cartridges, and Simbota came up delighted because the one-tusked bull had "looked" at him from 5 yards off.

On pacing the distances to where the brute had fallen it showed that the shots had been fired at 16 and 22 yards range. If only John—but regrets were no use, and his excitement was soon very satisfactorily sobered.

The spoor was easy enough to follow this time, with spurts of blood on the branches above our heads, and in several places the poor beast's droppings, stained a dark red. We expected to find him at every turn, and twice did we come upon clear proof of the tales that elephant will help each other. The wounded bull had started off alone, and in two different places several miles apart one could see where he had lain down in the shade of a tree and in some sand

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upon his side, and where his two companions had joined him, helped him up, and then the three trails went off together side by side, the outer bulls supporting their wounded comrade. Until late in the evening we followed, encouraged by the boys' assurance that he must be found in time, and luckily the three beasts altered their course and bore north bringing me close again to camp which I reached just as the sun was setting. Fish had been quite near to me in the morning when he heard the shots being fired, and had unsuccessfully tried to find our party in the bush.

Tuesday and Wednesday, 4th and 5th October.—At daylight we were on the spoor again together and twice got to within three hours of the elephant, when we had to stop, first of all to send for water and later on in the evening when it grew dark. Another night was spent on the trail, this time with the comforting companionship of Fish, for some elephant came quite near to us in the night, and some leopards were within a few yards of the fires.

With the dawn we were once more after him until the spoor became lost in that of a herd, which we got close to and found to only consist of cows and young. At times our bull was accompanied by one of his two companions, and by then our boys were beginning to get suspicious of his energy. They had been convinced that he would die on the first day when wounded, and their perplexity at not having already caught him up made them think that there must be some underhand work going on. Why did one at times see the spoor of one bull, and then the spoor of two bulls ?—Undoubtedly the bull was Mfiti—bewitched. He had been travelling in a huge ring, and we reasoned that he was avoiding the Portuguese country, and might even return to the place where he had been shot. Late in the evening when close to home we again found the spoor on a path just west of the camp, where he seemed to have wished to cross the Chelinda road, but had doubtless been scared by some travelling native.

Thursday, 6th October.—In the night he doubled on his tracks twice for long distances after which he seemed to be still travelling in a circle, so we tried to cut him off, and whilst I followed the spoor, Fish went straight along the Chelinda Road—where we met—with the elephant still walking 12 hours ahead.

I again followed on and Fish cut across the imaginary circle, and again we met on finding each other's spoor close to where I had first hit him, and still the elephant was 12 hours ahead. It had become ludicrous and we were nearly dead when we got to bed.

Friday, 7th October.—We couldn't do any more without a rest—but the old spearman was still game, and had stayed out on the trail alone all the night. After staying in camp for the day we got bored and broke every rule by going after kudu in the evening when we saw several cows but never a bull. Long after sunset the old man crawled

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into camp to give us definite news. Not only did he know where the elephant was but far far away he had even seen him—standing still and swaying his body, looking very sick and thirsty. Another chance had been lost—and before sleeping I solemnly vowed that I would go out the next morning and not rest in camp again until I had killed and sat upon an elephant.

Saturday, 8th October.—Camp was quitted at 3.30 in the morning or rather night. The old man led the way walking due north, whilst John regaled me with tales of elephant shooting, and tried to justify the apparent nervousness he had shown when we had first met the three bulls. With soft tones he whispered about the last Bwana whom he had accompanied on such a trip, and of how the Njobvu had charged and managed to catch the Bwana—and how he, John, had found the Bwana and had then "put back the Bwana's face and covered him up with some clean white limbo and made him nice." After that delicate operation John had taken the Bwana's gun and "I mine-selluf I kill-ed the Njobvu. Oh Bwana! We had plenty nyama and plenty fat that night." In fact John was a beast, who seemed to delight in trying to betray our valour of ignorance. Yet one liked him better when he talked of the boys and told one that James and George were rascals, Simbota and Kokwana the very best and truest of natives, and so on with such a lack of self-interest and genuine concern for our welfare that he always won our hearts. Of himself he knew but little, he said he was a Yao, but far too "intelligible" to belong to any tribe or religion in practice, and like every native had no idea of his age.

The old man was still leading when at 8 in the morning I smelt either elephant or else fresh dung, and to the boys' surprise insisted upon a cast around being made to see what it was due to. We immediately came upon fresh spoor of the bulls and soon afterwards the dung; and it was an example of how much keener the European's powers of smelling can be than those of a native. By 10 o'clock we arrived at a kind of kloof with a big curved valley beyond, and on entering it to our delight we heard in the distance the trumpeting of an elephant—in the boys' opinion an infallible good omen.

Soon afterwards we saw a bull. The country was not so thick as usual, and we could vaguely make him out under a tree some 50 yards away; and the old man said that he had also momentarily seen the other bulls with him, one of which was my big one. Stealthily we crept to a bush and an ant heap which gave cover 20 yards off them. I led and as we were after the wounded one it was only fair. The bull who was nearest was then quite visible and standing sideways on; the wind was imperceptible. John, who was calm for once had crawled to my left and whispered that from where he was crouching he could see the big elephant also, so I tried to take his place, when with a crash the nearest elephant charged sideways, and I fired. The

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first shot killed him. But a furious volley from Fish, myself, and John, who this time did excellent shooting although he would not have been trusted with the little gun had we not been thinking of our faces and of nice white limbo, made trebly sure of him. He was not a big elephant, with only about 30 lbs. of ivory per tusk, but that was worth £30 in cash and so quite worth getting. My shot had hit him in the brain and he had merely collapsed down on to his stomach, doubling up his legs so that he still appeared alive. Then began the song of triumph, when all the boys danced on his back and posed to have their portraits taken, and John sang his soft-toned song of "Nyama," "Nyaaama" in a cruel falsetto and broke out into more fearful tales of native life. This time he talked about the excitement of cutting up an elephant and the pleasures of getting inside an elephant, and he told of the boys inside having a hand cut off or being killed by mistake by the boys outside, when all were hacking and sawing together. Indeed Nyama is the open sesame to the heart of savage Africa.

Only the faintest glimpse of the other two bulls had been obtained, when they had plunged across our front, and the big wounded one was still running free. We followed at once taking the old man to track for us, and left behind a happy John beaming with joy at the prospect of enjoying himself unseen and inside the elephant. For hours we walked, lost the spoor, picked it up again, wandered on to the west till we reached a spot 5 miles north of Fort Maguire and on the edge of the lake.

A bathe refreshed us a little, but our food porter had strayed, and we had not had anything to eat since 3.30 in the morning, so we made for the village whilst the old man stayed behind to do his best alone. Fort Maguire was reached just as the sun was setting, and there to our relief we found our food which John had sent on with a native's instinct to the right place. In an open shelter by the edge of the lake and on two native hide beds we spent the night, worn to a shred, but at last the slayers of one bull elephant.

Sunday, 9th October.—At early dawn the trusty Kokwana and Simbota jogged back to camp, only 10 miles off, to get our bicycles. We were both feeling rather queer and Fish had a touch of dysentry so the jingas were welcome, but my bicycle seemed to have suddenly become very strangely wrong in the tyres, and I finally had to ride it in on the rim. We rested all day ; and in the evening after trying to mend the jinga tubes I gave up all hope and stuffed them with grass instead of air. John came in at nightfall with the ivory, and plenty of nyama to cheer the boys. Our camp was getting foul, and we felt nervous for our health so we decided to move away half a mile, and to only drink Nyasa water, a precaution which should have been taken some good time earlier.

James was responsible in part for our apprehension. Fish would

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always trust the rascal for some strange reason and made him responsible for the filtering and cleanliness of our water. Even the production of the last filter candle broken beyond hope of repair did not destroy that faith, and he continued to irritate John by consulting James on points of importance.

Monday, 10th October.—Nearly every day the local chieftain had sent us news of elephant being close to camp, and he had always proved to be a liar. His news that two big bulls had passed close by in the night seemed doubtful, but sure enough the spoor of one at least was found, and this was followed until 2 p.m. when it crossed the Chelinda road and where it seemed to be obviously looking for its mate. A rest was badly needed, so we sat by the track and speculated on the advisability of sticking to the chase when suddenly we heard the tinkle of a bicycle bell upon the road and that tra-la-la-la native singing which could only mean some traveller was coming by. Then round the trees came a jinga, and on it—James, the faithful mission boy, singing with pride from the proud height of Fish's bicycle, whilst two Tenga-Tenga ran by his side. With a shriek at sight of us James dashed into the bush and into a tree; down he fell and then disappeared. With a hue and cry the hunting party gave chase and after 10 minutes they all returned, not with James, he had bolted home too fast for anyone, but with only a badly broken bike. So the mystery of my own worn tyres was also explained. John was magnificent. With all the arrogance of a justly righteous capitao in whom implicit faith had not been placed, he lectured us. For long he had been jealous of the trust we had placed in those servants, and now at last he had his chance, and we had to listen to a terrible list of evil-doings. How bicycles had been daily ridden, how handkerchiefs had been worn as waistbands and clothes tried on and even beds laid upon when we had been shooting. "Oh, Bwana, why did you give your keys to James and George? How could you do it? Better if you had given them to Littlejohn, for Littlejohn he love you even as I John love you. Why did you give your keys? James and George are no servants who love their masters. What was George? A Chinde thief! And what is James? A Mission boy!"

In any case it was a serious offence and one not to be overlooked, for it struck at the very heart of our hold on the boys. That night we made our servants prisoners. With a small piece of string we tied James' right hand to George's left hand—the other hands were free—and with a few harsh words as to their disgrace expelled them from the companionship of camp to sit alone 100 yards away under a lonely tree until we chose to court-martial them in the morning. And all that evening big John and little John waited on us and tended our smallest wants with a care which had never been equalled, whilst Mother Wilfred popped in and out of the tent bowing and smiling like an anxious Café Royal chef, with on the salver—not some

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caneton sauvage or *truite saumonée*—but two fat slices of elephant trunk that stared mournfully at us with four blank holes as eyes. Poor James and George !

Tuesday, 11th October.—Fort Maguire owned one protector and representative of law and British rule. A single black policeman with a red fez reigned supreme in the district, and before dealing with our culprits we demanded that this dread personage should stand by and add to the solemnity of the court-martial. At 10 o'clock he marched into camp followed at a respectful distance by the village children, stood to attention and saluted. Our followers had never been so tense with interest and excitement during the whole of our journey. Verily I believe that the strength and backbone of our British rule in Africa are centred on the native love for the show and authority of a boma law court. No matter how trivial the case may be, the nigger demands and revels in the full importance of a magistrate's questions, questions which once obtained must be evaded at any cost. The Portuguese have failed to realize this, and so the native ignores them. Litigation of a sort with plenty of talk must of necessity take place somewhere ; if the white man fails to play up then their own chief supplies the want to a smaller degree, and rule is undermined.

James and George were still seated under their tree with heads bowed in shame ; sheepishly they were led up by the policeman to face us and the inquiry began. Not a particle of evidence could be obtained from a single boy ; John stood mute, Littlejohn vanished in search of butterflies, Simbota failed to understand, and Mother Wilfred salved his conscience by shrieking till we turned him out. Something had to be done, for although evidence was not forthcoming all knew of the misdeeds ; deliberately we hardened our hearts, asked for our keys and dismissed our servants. The policeman, as one who knew the hearts of every man, was ordered to find two more boys from Fort Maguire before the day was finished.

In the afternoon we went out to shoot and aimed at anything. Something was wrong with both of us, for Fish repeatedly fired his rifle at lumps of earth which he maintained to be wart hogs, and my own efforts though directed at living creatures were all yards from the mark. And we both felt very tired, something was so wrong that temperatures were taken and both were high, mine reaching 101·5.

At sunset the two new servants arrived, men of a very different stamp to our former retainers, both perfect savages but well dressed in long coloured night shirts, quiet and of a dignity which promised well. The old man also came home from his solitary searchings of the previous two days. Again he had seen my wounded bull and again would lead us out to him on the morrow. Before sleeping we had to face a dance and sing-song which our followers had got up in

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our honour. Some 20 women had been collected and for hours they wriggled and stamped and sang, and our Tenga-Tenga would leap up and bending forward with a hand on each knee moan out some wailing dirge about Njobvu and Nyama straight into our faces, till we "choka'd" them off to their beds. The slayers of an elephant were mighty men.

Wednesday, 12th October.—The hope of killing that big bull alone drew me from my bed, for I started with a temperature of 100. It was a coldish morning with misty clouds overhead and it soon began to drizzle with rain. Everything was unpleasant—but exasperation reached the limit when we found out that the old man had been deceiving us, and when he pretended that he was lost and politely suggested that he had been mistaken in seeing that big wounded bull and only thought he had seen it, we decided to waste no more time after elephant in those parts and to cross the lake to Angoniland.

By 2 o'clock I was back in bed. Fever had begun in proper earnest and my diary was finished.

From Thursday, 13th October, to 16th December.—My own recollections after that day are rather confused, and only a few things stand out prominent. I never felt really ill, but only uncomfortable and very angry at wasting my time. Afterwards there was rather a satisfaction at having gone the whole hog and at having thus sampled a dose of fever, although this illness was only some silly kind of tick fever mixed up with malaria. It made the experiences complete. At one time sleeping sickness was suggested, but that was unreasonable for sleeping sickness was never our way and had not at that time even reached Fort Johnston. One thing is certain and that is that without the constant care which Fish took of me I should never have got home at all, and Fish also had a small go of fever when first looking after me. For five days he dosed me and sweated me and then grew anxious and decided to make a hurried return to Malindi Mission Station, and thence to Fort Johnston where a doctor could be found. First of all a machila was made, but the jog jog jog of the untrained boys grew desperate and at Saidi Mazungu he tried to take me down the lake by night in a dug-out canoe. I can remember that, and also remember that I realized that when once wriggled sideways into the canoe with my head just above the bent-in sides, there was no getting out again. For the first few minutes all went well. It was a clear moonlight evening and one could see a few long crocodile snouts above the water. Then all of a sudden a huge spurt of water, 10 ft. long shot past the bows of the boat at a terrific pace. It was the first scared hippo who had been sitting on shore, and a succession of these torpedoes came so fast that the boys refused to go further by boat.

And I can indeed remember the behaviour of that new servant of mine, Saidi. His doglike care and devotion were perfectly wonderful;

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he had never seen me before and knew nothing about me, save that I was his master and sick, and with the first clear proof that I was indeed ill he made his bed on the ground beside my trestle and there lay watching me. Never once did I even stir and not see Saidi leap to his feet, waiting to see what he could get. His wife used to follow our camp from village to village and send us little cakes of native flour, which Saidi proudly produced and which we had to pretend to eat.

On the 20th Fish got me to the hospital at Fort Johnston, where I lay on my back for four weeks and after a hazardous journey alone down to Blantyre, for I could scarcely stand, I went back down to Chinde and home by Delagoa Bay to Pretoria.

Fish hung around Fort Johnston for some days, but nothing more could be done by him so he paid off my boys and went off to M'sanji—20 miles south—whence he sent me daily letters and there fell into some splendid luck. It was well deserved, for up till then his bag through no fault of his had been very small. Lion, rhino, kudu, water buck, impala, wart hog and several smaller buck and servals fell to his rifle within 10 days. Fish, unlike the writer, is not a talkative person (except when speaking Chinyanja) but his tale of his lion was nice. "I was lying down aiming at a wart hog. The beast was 150 yards off at the end of a narrow glade in the bush. Just as I was going to press the trigger a lion and a lioness jumped out of the bush and knocked over the wart hog for me. So I put the bullet into the lion instead. The lion fell down, got up again and both the brutes began to quietly walk towards me. So I plugged again and left him kicking close to the pig, and the lioness then skipped away into the bush. After making sure of the lion I also quietly walked up, when hanged if the lioness didn't jump out again to join her mate, think better of it, bag the wart hog and disappear with it! Just like a woman wasn't it?" And then he drowsily finished "I never saw her again." Between us we had done what we wanted to do, and had killed one fair head of nearly all the beasts of those parts. Original plans of trekking across Rhodesia to Broken Hill and of going by train to the Zambezi Falls were useless then, so after making final arrangements for me Fish pushed off to Chinde as fast as he could, and returned *viâ* Beira, Salisbury and the Falls to Potchefstroom which he reached on December 6th. Without that man's help I should never have gone to, nor have left Nyasaland. Let me now thank him.

At the Fort Johnston Hospital I was as well looked after as if I had been in England, and incessant kindness was showered on me from every direction. Boma men, settlers, and missionaries who lived alone many miles off sent books to read, men whom I have never seen sent birds and delicacies to be eaten, the Government promptly despatched a white nurse from Blantyre, and that lady travelled the 90 miles in two days alone, and with only black boys

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through country where lion may be heard and met on any night. The Acting Governor even cabled that Fish and I might each kill an elephant in the sacred Angoniland Reserve. All these people and many others had merely heard that some fellow who was out for a day or two had had bad luck, and instinctively wished to help him. That magic word "Luck!" Nyasaland taught one, if it taught nothing else, how much could be meant by the casual "Good luck to you" of the passer-by who wished us well on our trip.

And of the boys as well there was much to remember; with all their childish cunning and begging and fearsome greed and coarseness, they taught one many a lesson of simple faith and of nature at its best. Somehow Fish managed to extract from his jinga boy our native names. His own was splendid in its direct and homely thrust. "Chipolonga," what need to say its meaning "Plenty plenty sleep." My own was rather dull and evidently due to John overhearing Fish, but it was yet strange to find oneself called by the same old nickname, even by Nyasaland natives. "Chekopa." "Skin."

James I never saw again, but those two servants hovered about our camps and were seen in the nearest villages for days after their dismissal. And I can dimly remember how one night when lying on my back at Fort Johnston I was told by Saidi that a boy wished to see me. When I looked up there was poor George standing by my bed with a bowed head and outstretched hands. What more touching appeal for mercy can be read than this letter from James to Fish.

LUNGWENA, *October 14th.*

DEAR SIR,

Many kind regards to you our Sir. Please excuse us to receive our letter. Yes Sir we besseech you about your wheel. Yes we understand that we make wrong thing to ride up at your wheel, but now we coax you Sir to spare us; and the wheel did not ride George, but I ride—me only—till Chelinda. And when you meet us on road you did not scold us. . . . I know that John told you these words, but he is very liar. We cannot to employ your dress to put on, we cannot to sleep on your bed; but we know its cause, because when you were going to hunting, when chief Kululanga was coming when you were called me to explain you well, Capitao John when was hearing these words was very grumble about me, for that cause he hated us. And when we asked the caravan porters they refused indeed that we cannot to sleep at your bed or to put on your things. Howbeit now we know that George and me our Country are very far, and we believed that we have our Masters who can to help us when we shall get affair at law; we were hoping so, because we motherless we fatherless here, our Fathers and our Mothers and Master are you, and now please excuse us to recall at your work; we understand that if a man has miss you can spare them; everybody no one can not do wrong; and please we emblase your feet, we lie down at your feet to recall us at your work. We lie down our pencil.

GEORGE AND JAMES.

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But James was a rascal, though Fish won't admit it, and I believe that those two still write letters to each other.

Of course I saw John again. He was one of the first sights of Blantyre, dressed in a new suit of clothes with a huge white collar round his neck and riding the remnants of Fish's bicycle. He met me with every protestation of delight and promptly began to beg for a souvenir of my existence and to trick me in every conceivable manner. Even Fish agrees that John was a rascal.

The meeting with Simbota was quite dramatic. That journey alone from Fort Johnston to Blantyre with new and quite dull boys was rather an undertaking. They had never seen the Bwana before, and knew that their only job was to carry his machila for the 90 odd miles as far as Blantyre, and not having the character of a Saidi they gave incessant trouble the whole way. That made me eager to get through quick and I tried to do too much. The usual route is *viâ* Zomba, slightly longer than the short cut which I attempted to do in four days through Mpimbi and Lirangwe where water is scarce.

On the 4th day the trouble was getting serious and when 15 miles out of Blantyre the boys were refusing to go on, who should appear coming towards us but Simbota. In front of him he had a small picanin carrying a little bag of flour, and the good fellow whose home was 30 miles south of Blantyre was casually walking the 120 miles to pay me a call at Fort Johnston, and doubtless to extract presentis. He quickly summed up the situation and we were soon under way again. But trouble was not quite over, for it rapidly grew dark and the first severe rains I had seen in Nyasaland commenced. Then night really fell and we could not see a yard ahead of us; the track twisted in and out of trees, bundles of grass were lit but the rain put them out and the machila had to stop. Without Simbota I should never have got on at all, for he and one other boy carried me under the arms for 3 miles and plumped me on the floor of a startled settler who had just finished dinner.

During that journey Saidi had been unable to help me by day, for he was left in charge of the few odd porters who carried my kit, as distinct from the machila boys who travelled fast, but those Tenga-Tenga were never late. And when in the hospital at Fort Johnston the doctor had been hardly able to allow the native to sleep in my room, but he let him sleep on the door mat, and although that hospital had a trained boy to look after me there was no real personal work that Saidi would ever let the stranger do. However he had his small reward in the end for a good master took him over from me; and as Saidi gave one last push at the boat on the Chinde sand, a lady, also travelling home after several years up country, turned to me and said "Who is that boy who seems so sorry to see you off? I never saw such a charming-looking native in all my life." And Saidi understood.

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AN ENGINEER OFFICER UNDER WELLINGTON IN THE PENINSULA.

(Concluded).

(*Edited by* COMMANDER THE HON. HENRY N. SHORE, R.N., RETIRED).

NOTE.—The following sketch of Wellington's most trusted and daring Intelligence Officer, Capt. Colquhoun Grant, mentioned above, was published anonymously, some time ago :—

It is much to be regretted that the Duke of Wellington never condescended to write the history of his intercourse with Capt. Colquhoun Grant. A volume on that subject written by such an accurate and unimaginative chronicler as the Duke of Wellington would have been a classic for all time. On such a theme, the baldest and most prosaic recital of the hero's deeds would have been more thrilling than a novel. That he acted habitually under the guidance of the Duke of Wellington, and held communication with no other English officer, is well known; but it was also his invariable practice to wear his uniform wherever he went and never to assume any disguise. Of course, his usual method of entering the enemy's lines was in the character of a deserter from the British army; and the excuses which he invented to account for his desertion were as inexhaustible as they were ingenious. Sometimes he posed as a cavalry trooper, and sometimes as a private in an infantry regiment who had stolen a thoroughbred horse from some Staff officer on which to make his escape with salutary speed. He was generally attended by a Spanish peasant named Leon, upon whose quickness of apprehension, fidelity, and vigilance he placed, after some experience of his good qualities, the most absolute reliance.

Hanging on the flank of Marmont's army until it passed the Coa, the indomitable Colquhoun Grant soon discovered that the French had left their scaling-ladders behind them, and, therefore, had no real intention to attempt the recapture of Ciudad Rodrigo. Being anxious to ascertain by what route Marmont would proceed to Coimbra, whither his head was pointed, Colquhoun Grant and Leon (the latter on foot) hid themselves on a low ridge, covered with dwarf oaks, at the foot of which lay a pass which the French army seemed likely to traverse. Unfortunately, some French sharpshooters, posted on a higher ridge, descried the two companions as they withdrew from the road below and plunged into the forest. In a few minutes a cry of "The French! the French!" issued from Leon's lips, and the foe, represented by a dozen mounted dragoons, was upon them. Exhausted by running, poor Leon fell, and was instantly

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transfixed and killed by a French spear. Striving in vain to protect his fallen friend, Grant was captured and carried before Marmont. The latter, who was one of the few gentlemen to be found among Napoleon's Marshals, treated his prisoner kindly and invited him to dinner. As usual, his uniform saved his life; but after they had left Marmont's headquarters, under an escort charged to convey him from Spain to France, Grant found to his surprise, on arriving at Bayonne, that Marmont had written to the commandant of that town and garrison explaining that Grant was a very dangerous and daring spy, who had done the French armies in Spain no end of harm, and that he was to be put in irons and sent to Paris.

They had to reckon, however, with no ordinary man in Colquhoun Grant. Divining the contents of Marmont's letter, by that intuitive instinct which, like a cat's whiskers, guided him in the dark, he contrived to escape from Bayonne by night, scrambling down into a deep fosse upon his trusty thoroughbred, from whom he had never parted company, and climbing up the almost perpendicular slope on the other side. By some kind of freemasonry, known only to bold spirits, he introduced himself on the road to General Souham, who was on his way back to Paris, and craved permission to join his party. Describing himself under a false name as a paroled British officer, Grant delighted his companions with his versatility, and by his description of moving adventures which he invented for their amusement. On arriving in Paris, he made himself known to another English spy, who had long been a member of the French police, and in constant communication with English agents, who carried his secret reports verbally to London, which they reached through Spain, Antwerp, or Rotterdam. His Parisian colleague told him that a passport had just been made out in favour of Jonathan Buck, an American, who had died suddenly on the day when the passport ought to have been claimed. Boldly demanding this passport, which carried him safely through every obstruction, Grant rode his faithful steed down to Nantes, where he intended to embark on an American ship. Her departure was, however, delayed, and with his accustomed courage, he told the American captain his story, and sought his advice. With kindly sympathy the American skipper bade him assume the character of a discontented sailor, and supplying him with a rough nautical dress and with forty dollars, told him to lodge the money in the American Consul's hands, upon which he would receive a certificate authorising him as a discharged seaman to proceed from port to port in search of a ship.

August 30, 1811. Accompanied Genl. Craufurd by the left of the Pass of El Fortin. The Guerillas of Don Juan Sanchez dancing, etc., by moonlight with the inhabitants. *Sunday, Aug.* 31. Rode with the General along the ridge of the Sierra towards Torredecilla, till we could overlook Cadalso. Came back to Robledilla to dinner in the evening by way of the Convent of N, S. de los Angelos, where we were very hospitably treated. Returned next morning to Martiago.

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NOTE.—From Sept. 1st onwards, Jones was employed daily in examining the country, either with Genl. Craufurd or alone, or riding over to Lord Wellington's Head Qrs. at Guinaldo, where, on Sept. 12, he found orders for him to return to England. (By Genl. Mann, dated Aug. 16).

Sept. 18. Genl. Craufurd went with Wood towards Tamanes, to ascertain the movements of the enemy, who show an evident intention to relieve Ciudad Rodrigo. Rode with Ross to Las Agallas, to the position where his guns are to be posted; returned in the evening.

General Craufurd remained at the front till the 21st, when a body of the enemy's cavalry entering Tamanes obliged him to retire to Martiago again. *Sept.* 23. The Light Division took post along the Vadilla, and bivouaced. The head of the enemy's columns showed themselves in the plain before Ciudad Rodrigo. *Sept.* 24. The plain of Ciudad Rodrigo appeared filled with troops of the enemy, and a string of mules, etc., for many miles in extent entering the place. The enemy occupied Atalaga close to our front with two battalions of infantry and a regt. of cavalry.

NOTE.—The above operations are thus explained by Napier:—Ciudad Rodrigo wanted food, and Marmont arranged a combined operation for its succour, with the result that, on the 21st Sept. he had assembled 60,000 men, 6,000 being cavalry. On the 23rd, the French encamped to the north-east of the fortress, and a strong detachment, entering the plain, communicated with the garrison, examined the position of the Light Division, and returned. Next day, the whole of the French cavalry, and 4 divisions of infantry crossed the hills in two columns, and placing some troops in observation on the Vadillo introduced the convoy. Next day, (25th) the French advanced against the allies, and there ensued the combat of El Boden.

Reverting to the Diary:—*Sept.* 25. Soon after daylight a cannonade commenced upon our left towards Pastores, and continued till noon, when it became much warmer. Observed several movements of troops between El Boden and Pastores, on the other side of the Agueda. The firing appearing to advance towards the heights in front of Guinaldo, it was decided that our Division should withdraw from our position which appears hazardous. At 3 p.m., soon after orders had been given for that purpose, directions arrived from General Murray to the same effect. The rear of the division broke up at sunset, marched the greater part of the night, and bivouaced near this village (Cespedosa) being too much fatigued to reach Robleda as intended.

Sept. 26. Marched at daylight to Robleda;—the ford of Canos, understood to be in the enemy's possession; the Light Division crossed the Agueda at the ford of Penaparda, and moved into its post before Guinaldo by midday; the enemy about a mile from our

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advanced posts in three large bodies, said to consist of 60,000 infantry and 5,000 cavalry; 22 battalions of the Imperial Guard were conspicuous amongst the crowd.

NOTE.—And yet, Napier states that—"the Light Division should have marched by Robledo to Guinaldo; Craufurd received the order at 3 o'clock, heard the cannonade, and might have reached Guinaldo before midnight; but fearing a night march he only moved to Cespedosa." And that, next day, the Light Division, "compelled to make a circuit, did not arrive till after 3 o'clock in the evening."

Sept. 27. So soon as it became dark last night, the army began to retreat, leaving the Light Division in Guinaldo until midnight, when we also retired; but the road was so crowded with baggage, etc., that it was daylight before we passed through Cossilas de Flores; continued our march to Furcalhas where we halted, our Division being ordered to take post there; but not finding any tenable ground, we moved into the position behind Aldea da Ponte, having the 4th Division upon our left, who were pushed by the enemy at dusk, which obliged us to stand to our arms several times, though we were not attacked.

Sept. 28. At 2 o'clock this morning retired from our position near the Convent of Sacapata through Alfayates, and bivouaced in the Chesnut wood close behind the village of Soita; drizzling rain all day. The French retired from Aldea da Ponte towards Ciudad Rodrigo, not choosing to attack us in this position.

NOTE.—Napier, commenting on the perilous situation of the Light Division during the night and morning of Sept. 25, and 26th, on the march to Guinaldo, states that, when Marmont heard of the escape of the Division, he—in allusion to Napoleon's fortune, prophetically exclaimed,—"And Wellington's star also is bright!"

The French having retired, the Light Division, reinforced by some cavalry, resumed the nominal blockade of Ciudad Rodrigo in concert with Julian Sanchez, and the rest of the army was cantoned on both sides of the Coa, head-quarters being fixed at Frenada.

October 2. The Light Division moved into the Cantonment assigned to it, viz., Cossilos de Flores, Puebla da Azava, Castillego, and Fuente Guinaldo where Genl. Craufurd established his Head Qrs. I got the quarter formerly occupied by Col. Fletcher in the Market-place. Head Qrs. said to be at Frenada over the Coa. *Oct.* 6. Riding over the scene of the action near El Boden with Genl. Craufurd, we started 2 hares, killed one and brought it home with us. *Oct.* 8. Coursed with the Genl. near El Boden, killed a young wolf or fox, and a hare. *Oct.* 14. The Governor of Ciudad Rodrigo taken and carried off by the Guerillas. *Oct.* 30. The Tragedy of Zanga performed by the officers of our Division in the Theatre, made in the Chapel near the town.

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FUENTE GUINALDO, *Oct.* 9, 1811.

MY DEAR FATHER,

. . . The *Gazette* will, long before you receive this, have made you acquainted with their (the enemy's) success in relieving Ciudad Rodrigo, and obliging us to retire from a position near this town, on the night of the 26th Ult., to another on the banks of the Coa, where it would seem we were to have awaited the enemy's attack, but where however they (having effected their object) did not choose to attack us. On the 25th they made a strong reconnaissance with their cavalry near El Boden, and were gallantly received by part of Genl. Picton's Div. and our Dragoons and Hussars, in consequence of whose rapid retreat our Division, 4 or 5 leagues in front and on the enemy's side of the Agueda, were for a short time completely cut off from the rest of the Army. Marching that night nevertheless enabled us to rejoin the Army in front of this town on the 26th; and on the night of the 26th, or rather, early on the 27th we formed the rear guard of the Army upon its retreat. In the evening they (enemy) came up to us, and attacking with great superiority of force, carried the hill upon which the Fusiliers (the 7th and 23rd) were posted; though, if I am not mistaken, they paid its full price before they occupied it. The next morning we took up a position near Saita, but there, as I said before, they did not care to follow. Accordingly in a day or two we advanced again, and have reoccupied this and the neighbouring places; Head Qrs. are at Frenedas, not far from Almeida.

I am rather surprised that Capt. Ellicombe has not yet reached Lisbon; everything appears so quiet, at least for several months, that I care not how soon he relieves me. As soon as we hear of his arrival I shall set out for Lisbon; but you cannot expect me in England in less than a month, or five weeks afterwards . . . yet it cannot be very long if we live, before I have the pleasure of seeing you, and of presenting to you *verba voce*, what I can only now do in writing; with assurances of my most dutiful love . . .

Your very loving son,

RICE JONES.

FUENTE GUINALDO, *October* 23, 1811.

MY DEAR FATHER,

My only inducement to write to you at this time, is to let you know that I am still waiting the arrival of Capt. Ellicombe at Lisbon, which surely cannot be delayed much longer. We continue precisely in the same state as when I wrote last. I am in as good, if not better health (Thank God) than I ever have been in this country; and was it not for the unpleasant state of suspense, that must of course continue until I set out for England, should be more comfortable also; for nothing can exceed the civility and attention of General Craufurd. . . . I am totally in the dark as to what is likely to be my future destination. There can be little doubt of my returning in a Packet, and consequently landing at

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Falmouth. I calculated in a former letter that it would take about a month for me to reach England from the time of my quitting the army here.

You have, I daresay, already heard of General Reynaud, the French Governor of Ciudad Rodrigo, and a quantity of their cattle, being taken by Don Julian Sanchez's Spanish Guerillas; it has afforded us a good deal of amusement.

Nov. 3rd and 4th. Spent both days with Genl. Craufurd forming schemes to cut off the cattle the enemy send to graze daily; for which purpose we approached the place, often very near, upon all its sides. *Nov.* 11. General Craufurd still wishing to cut off the cattle from Ciudad Rodrigo, took me with him again to the hill near Pastores. Found their place of pasturage changed to the opposite bank of the Agueda. *Nov.* 12. Accompanied the Genl. in a minute reconnaissance of the ground from the road from La Caridade to that from Salamanca to Rodrigo, with a view to the execution of his scheme for intercepting the cattle when sent out to graze, returning to Fuente Guinaldo in the night.

Nov. 21. Col. Fletcher, Capt. J. T. Jones, Burgoyne and Mulcaster came to see Henry the 4th performed at our Theatre. They dined with me, and slept in my quarters.

NOTE.—And here, a short extract from Gleig's *Life of the Duke of Wellington*, may fitly find a place:—"Of toil and suffering, and danger too, the troops had from time to time enough; but every season of repose, and especially the winter, brought great enjoyment in its train, into which no one entered more heartily than the Duke of Wellington himself. . . . If Lord Wellington favoured one of the Divisions of the army more than the rest, it was the Light Division . . . the regiments composing it were models of all that good infantry ought to be; the men well drilled, the officers punctiliously attentive to the minutest details of duty, yet full withal of life and spirits. Among other accomplishments several of these young men possessed a decided talent for acting, and this winter they brought it into play."

Dec. 13. Accompanied Col. Fletcher to Almeida, which is repairing under Capt. MacCulloch's superintendence.

FUENTE GUINALDO, *Nov.* 20, 1811.

MY DEAR FATHER,

I have delayed writing until the last moment in hopes of hearing of Capt. Ellicombe's arrival at Lisbon. A Mail, with letters to the 16th Oct. arrived here yesterday; another day would have completed 8 full weeks without our getting either a letter or paper from England. The winds which caused this unparalleled blank in our communications has doubtless prevented the sailing of the vessel in which my expected relief is

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embarked; but if the fine, North-Easterly gale which has prevailed the last week or ten days will last a day or two longer, I think I shall hear of his arrival, in another week at the most; and may then, if I get a favourable passage, have the pleasure of eating my Christmas Dinner with my dear Father. We have not a word of news; things have as quiet an appearance as ever. My health, thank God, continues excellent. I wish much I could hear how you all are; but I fear you have, in the expectation of my more speedy return, given up writing to me altogether.

FUENTE GUINALDO, *Dec.* 4, 1811.

MY DEAR FATHER,

I was yesterday favoured with your letter of the 9th Ult. from Bristol. . . . The delay attending Capt. Ellicombe's reaching Lisbon is extraordinary; I believe he was ordered in the middle of August last—nearly 4 months ago, and the voyage does not commonly exceed a fortnight, but as yet we have not heard a syllable of him. I see by the Papers (which we have received to the 12th Oct. only) that several outward-bound convoys were at that time in Cowes Roads awaiting a favourable wind . . . and I conclude are at this moment at anchor in the Tagus. . . . Yet I must give up the idea I entertained when I last wrote, of being in England on Christmas Day—at least, reckoned by the New Style—by the old one, it is still possible. . . . We advanced, a few days ago, across the Agueda, to intercept a Convoy which was said to be on the point of entering Ciudad Rodrigo; but it did not appear at all, and we accordingly returned to our Cantonments here.

NOTE.—For some time past, Wellington's preparations for the Siege of Ciudad Rodrigo had been carried on unknown to the French; and Almeida was now being repaired to afford security for the siege stores and battering-train, which had been introduced, under pretence of being an armament for the new works. At the same time, a trestle-bridge to throw over the Agueda had been prepared secretly in the arsenal of Almeida. "Thus the preparations for the attack"—says Napier, "advanced while the English general seemed to be only intent upon defending his own positions." And he declares that not even the engineers employed in the preparations knew more than that a siege or the simulation of a siege was in contemplation; but when it was to be attempted, or that it would be attempted at all, none knew;—even the quarter-master general, Murray, was suffered to go home on leave with the full persuasion that no operation would take place before spring."

Reverting to the Diary:—

Fuente Guinaldo, Dec. 18. Received orders to prepare Fascines, etc., at the several quarters occupied by the Light Division. *Dec.* 20. Lord Wellington inspected the Division. *Martiago, Dec.* 23. Came

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here, after setting the parties of the 43rd to work at fascine-making. *Dec.* 24. Gave directions to the 52nd, at Martiago and the neighbourhood, to make fascines and gabions, and returned at night to Fuente Guinaldo. *Dec.* 25 (Xmas day). General Craufurd, Wood, and myself met General Stewart to course near Fuente de Onora, and dined with him. *Martiago, Dec.* 29. Inspected the parties of General Vandeleur's Brigade employed making fascines at Martiago, and slept there.

1812. *January* 2. Heavy snow this morning caused much inconvenience, and the subsequent postponement of the movements ordered for investing Ciudad Rodrigo. Went to Las Agallas to expedite the transport and collection of the fascines and gabions made by the Light Division.

LAS AGALLAS, *Jan.*, 1812.

MY DEAR FATHER,

After such an extraordinary delay of my return to England, I fear the prospect is still rather distant; for although Capt. Ellicombe must undoubtedly have joined the Army before now, I have not as yet heard of his arrival; and the siege of Ciudad Rodrigo which it seems certain we shall now undertake, has, I doubt not, induced Lord Wellington to postpone my leaving the army until its termination, which will account for my not having heard from Col. Fletcher on the subject lately.

The armies of Marmont and D'Orsenne are said to be much separated and very distant; yet I fear they will advance and unite long before the completion of our labours, and oblige us to raise the siege—perhaps to recross the Coa. Our experience last summer at Badajoz has made me much less sanguine than I should otherwise feel at the prospect of a siege; but as we are now to be engaged in it, it is certainly much better that I should remain and see it out, than leave my brother officers in the midst of it. Let what will be the result, I have the satisfaction of knowing that my long procrastinated stay in this country, so far from being my own wish, has been quite contrary to my inclination; and I therefore most steadfastly rely upon the Providence which has hitherto attended my steps ordaining it all for the best.

We have for the last ten days been making Fascines and Gabions for the siege, and have this morning begun to move them to our Park before the place. It is some days since I have seen or heard from any of our officers, and I am therefore not aware when we break ground—I have heard to-morrow night, or the night after. I am afraid we shall experience very bad weather; we had a good deal of snow yesterday; but it is now fine again. . . . Adieu—and God bless you.

Your very loving son,

RICE JONES.

NOTE.—Once more, we must turn to the Historian for explanations:—"The favourable moment for action so long watched for by

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Wellington came at last. . . . The Imperial Guards, 17,000 strong, being required by Napoleon for the Russian campaign, marched in December to France. All the Polish battalions, and several thousand choice men destined to fill the ranks of the old guard were drafted; so that not less than 40,000 of the best soldiers were withdrawn, and the maimed and worn-out men being sent to France at the same time, the force in the Peninsula was diminished by 60,000 men. . . . Marmont also, deceived by the seeming careless winter attitude of the allies left Rodrigo unprotected and Wellington instantly jumped with both feet on the devoted fortress."

Jan. 8. About noon, Ciudad Rodrigo was invested by the Light Division; during the afternoon 269 cars arrived with tools, etc., from Gallegos, having crossed the Agueda by a bridge on trestles made by the Staff Corps. A Park formed near the road, about 1,800 yds. from the place. Soon after 8 o'clock in the evening Lieut. Thomson led a party commanded by Col. Colborne, to storm the new Redoubts, which was soon carried, and a party of 700 men set to work immediately—300 to form a lodgement in the Redoubt, and 400 to open a communication to it. The enemy fired upon the redoubt all night.

NOTE.—Discussing Lord Wellington's extraordinary resourcefulness in emergencies, Mr. Larpent, the Judge Advocate-General of the army under his Lordship's command, writes in his Journal of the war:—"I heard an anecdote about the siege of Rodrigo which shows the man. On a sudden the army was in front of it. A new work had to be taken on the instant; scaling ladders were necessary; the Engineers had none,—being quite ignorant of the plans; an inconvenience which has often arisen in different departments, from Lord W.'s great secrecy—though the general result, assisted by his genius has been so good. Lord W. on being informed of this—"Well," said he, "You have brought up your ammunition and stores, never mind the waggons; cut them all up directly, they will make excellent ladders—there, you see, each side-piece is already cut." This was done, and the work scaled forthwith.

Major Dickson, (better known as Sir A. Dickson) an officer after Lord Wellington's own heart, wrote in his Diary, at the first siege of Badajoz, where he was entrusted by his Chief with the control of the artillery arrangements,—"I have transacted business with many generals, but never such a one as Lord Wellington, both for general knowledge, and attention to reason and suggestion."

Jan. 9. 400 men were employed all day to complete the work opened last night. At night, the working parties consisted of 1,200, and the covering party of 500; the parallel was opened to its whole length, about 600 yds.; and three batteries for 11 guns each were also begun. Ross was killed early in the morning, near Battery

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No. 1, reckoning from the left, by a shot from the Convent of San Francisco. (Brother of Ross of the Horse Artillery).

NOTE.—Details of this remarkable siege being fully given in Sir J. T. Jones' work, we will pass on to the assault, in which exploit Rice Jones took a prominent part :—

Jan. 19. The breaches appearing practicable, a storm is determined upon. A few minutes before 7 this evening the troops moved to the assault. Joined the Light Division, and by order of Genl. Craufurd accompanied the advance under Major Napier. After carrying the breach, a French officer conducted me to the Governor's house, General Barrié, who was soon after brought in himself. Having taken possession of his Papers, etc., I left my orderly, Private Roger O'Niel, to take care of them and the inhabitants of the house, and returned to the Engineer Depôt.

NOTE.—We are fortunately enabled to supplement the Diarist's all-too-brief account of the storming of Ciudad Rodrigo, by a somewhat more detailed narrative of that dashing exploit contained in a letter to his Father, written on the following day :—

CAMP BEFORE CIUDAD RODRIGO,

20th Jan., 1812.

MY DEAR FATHER,

I have barely sufficient time to acquaint you with the happy termination of our labours at the siege of Ciudad Rodrigo, by our carrying it by assault yesterday evening. The day after I wrote to you last from Las Agallas we invested the place, took the new Redoubt of San Francisco and opened our First Parallel on the following days, we were so highly favored by weather, and other circumstances, as to get possession of the Suburbs and Convents, erect our Batteries and effect a practicable breach yesterday evening. In doing this we have met with considerable loss; amongst others my good friend George Ross was killed with a splinter of a shell on his head; soon after our commencement;—no man ever fell more universally regretted. In storming the town last night I fear our loss was great;—and I am sorry to say my friend and General (R. Craufurd) was dangerously wounded, yet I am happy to say we are not without hope of his recovery. I had the good fortune to lead the 52nd and 43rd Regts. to a small breach, to the left of the large one which General Picton entered, with little loss except Major Napier whom I accompanied and who lost his arm. We were together in the second or third file, and were at first repulsed and driven headlong down the breach;—but shortly after tried again and gained it. Thanks to the providence of that God upon whom I have always relied, I escaped this rough treatment with a slight scratch of a bayonet on my thigh, and a contusion on my breast, when I was pushed down the Breach:—which I however feel not the slightest inconvenience from at present. I shall be very busy the next 3 or 4 days dismantling our batteries, and repairing

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the breach :—after which I expect to set out on my return to England :—when I hope for the pleasure of finding you all in good health.

From your very loving son,

RICE JONES.

The death of his friend is thus referred to by Southey, in his History of the War :—"Capt. Ross of the Engineers was brother of that excellent officer who afterwards fell at Baltimore, and was himself a man of great professional promise, uniting with military talents, a suavity of manners, and a gentleness of disposition. His friend and comrade, Lt. Skelton, was killed at the same time and buried with him in the same grave, in a little retired valley not far from the spot where they fell. Capt. Jones (the Historian of the war) placed a small pedestal with an inscription to mark the grave, and with prudent as well as Christian feeling, surmounted it with a cross. That humble monument has, because of its Christian symbol, been respected ; Spaniards have been seen kneeling there, and none pass it without uncovering their heads."

Jan. 20. The 5th Division under Genl. Leith occupied Ciudad Rodrigo, and proceeded with all speed to fill up our works and trenches ; after which, Lord Wellington gave Col. Fletcher permission to send me to England, agreeably to orders. General Craufurd buried with all possible honour at the foot of the breach.

NOTE.—The extreme severity of the conditions under which this siege was conducted, will be understood when it is stated that—"the period of the year was the commencement of January, when there is more dark than daylight,"—I quote from the remarks of Sir J. T. Jones, Royal Engineers, who was present as Brigade Major. "Secondly, the weather was bitterly cold at night, and the ground frozen. Thirdly, the men employed to raise the batteries were on the march, or on duty, for thirty hours consecutively ; and the troops, having to march every morning from their different cantonments, six or eight miles distant from the trenches, were fatigued before they began to work." And what made it all the more trying was that many of the troops had to cross the river nearly up to their shoulders, and remain in this wet state until they returned to their quarters. It is not surprising, therefore, that "as whilst they remained on duty they could not take any rest from the extreme cold, they became worn out and incapable of any exertion long before the expiration of their tour of 24 hours' work, which materially impeded the progress of the work." In spite of all these drawbacks, Sir J. T. Jones tells us that every man felt confident of success, and acted accordingly. Patient and indefatigable at work, impetuous and daring in the assault, they shone throughout this siege in their proper light, and gave strong proofs of possessing superior qualities for such undertakings."

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CIUDAD RODRIGO, *Jan.* 28, 1812.

MY DEAR FATHER,

At length everything is settled so as to allow of my returning to England, and to-morrow morning I intend setting out for Lisbon, where I expect to arrive about the 8th Feby. I shall not be able to leave Lisbon in less than a week, which will make it the 16th before I can probably embark, and with the blessing of God and a fair wind, I may have the pleasure of landing in England a fortnight afterwards; I continue, thank God, in excellent health and spirits, and if we are favoured with more of the beautifully fine weather we have had of late, the march to Lisbon will be by no means disagreeable. But I have such an aversion to the sea that I cannot say I look with so much satisfaction at the prospect of the voyage—short, even as it is.

Since I wrote last week, we have been busily employed, levelling the works we had raised against the place; re-forming and enlarging the Redoubts we stormed the first night; and repairing the two breaches in the main wall, all of which is now completed, or very nearly, at least, so as to place this city in a state of security from assault.

The French army which Marmont had assembled at Salamanca, for the relief of this place, after pushing some small corps about 6 or 7 leagues from hence, have, it is said, retired again behind the Tormes.

Poor General Craufurd, after severe suffering from his wounds, expired on the 24th Inst. In him I have lost a warm and valuable friend, and the Army one of its bravest, and most scientific officers. Few had the opportunity of forming a just estimate of his real worth, except those who lived at his hospitable table, and saw him in his quiet and domestic moments. . . .

Your very affectionate son,

RICE JONES.

Jan. 30. Bade farewell to the army I have served with so long, and proceeded on my way to Lisbon.

Feb. 16. Embarked in the *Lady Arabella*, Packet, Capt. Porteous; got under weigh about 7 o'clock next morning; blowing tempestuously which soon carried us out of sight of the coast. Came to anchor in Falmouth at 11 o'clock at night, on the 24th. Set off at 2 a.m., next morning in the Mail from Falmouth; breakfasted at Truro, dined at Launcestown, and slept at Exeter. Disagreeable weather;—wind and sleet; very cold on the Downs. There being no place to be had inside the Mail at Exeter, I rode on the outside as far as Salisbury, where I took the place of another passenger and travelled all night. *Feb.* 27. Arrived in London greatly fatigued and exhausted by my journey. *March* 25. Commenced to do duty at Woolwich.

NOTE.—The rest of the Diary being chiefly concerned with matters of family interest, need not detain us.

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A TARDY RECOGNITION.

On the 17th July, 1847, an official communication, addressed to "Colonel R. Jones, The Commanding Royal Engineer, Gibraltar," to the following effect, was received :—

"Colonel Rice Jones is requested to forward to this Office the statement herein required, addressed to the Secretary of the Board of General officers, specifying the Battles or Actions for which he has received a medal."

GENERAL ORDER. No. 582.

HORSE GUARDS,
1st June, 1847.

28th June, 1847.

Her MAJESTY having been graciously pleased to command that a Medal should be struck to record the Services of Her Fleets and Armies during the Wars commencing in 1793, and ending in 1814, and that one should be conferred upon every Officer, Non-Commissioned Officer, and Soldier of the Army, who was present in any Battle or Siege, to commorate which Medals had been struck by command of Her Majesty's Royal Predecessors, and had been distributed to the General, or Superior, Officers of the several Armies and Corps of Troops engaged, in conformity with the Regulations of the Service at that time in force;—General and other Officers, Non-Commissioned Officers, and Soldiers, who consider that they have claims to receive this Mark of their Sovereign's gracious recollection of their Services, and of Her desire to record the same, are each to apply to the Secretary of the Board of General Officers, Whitehall, London, and to send in writing to the same Officer, a statement of his claim, for what action at what period of time, and the Names of the persons, or the title of the Documents by which the claim can be proved.

(Here follow instruction with reference to the submission of claims).

. . . . . .

The occasions, for which Medals have been granted by the Sovereign, are specified in the annexed page for general information and guidance, as at page 73 of the *Annual Army List*.

By Command of Field Marshal,
THE DUKE OF WELLINGTON,
Commander-in-chief.

JOHN MACDONALD,
Adjutant-General.

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Honorary Distinctions have been granted to officers in Commemoration of their Services in the following Battles or Actions :—

Maida	4 July, 1806	Badajoz... ...	{17 March / 6 April} 1812
Roleia	17 August, 1808	Salamanca ...	22 July, 1812
Vimiera... ...	21 August, 1808	Fort Detroit, America	August, 1812
Sahagun, Benevente	{Dec, 1808 / Jan., 1809}	Vittoria... ...	21 June, 1813
Corunna ...	16 Jany., 1809	Pyrenees ...	{28 July / to 2 Aug.} 1813
Martinique	...Feby., 1809	St. Sebastian ...	Aug., Sept., 1813
Talavera ...	27, 28 July, 1809	Chateau Guay, America	26 Oct., 1813
Guadaloupe ...	Jany., Feb., 1810	Nivelle	10 Nov., 1813
Busaco	27 Sept., 1810	Chrystler's Farm, America	11 Nov., 1813
Barrosa... ...	5 March, 1811	Nive ...	...9 to 13 Dec., 1813
Fuentes d'Onor...	5 May, 1811	Orthes	27 Feb., 1814
Albuhera ...	16 May, 1811	Toulouse ...	10 April, 1814
Java ...	Aug. and Sept., 1811		
Ciudad Rodrigo	January, 1812		

The following reply was forwarded, in response to the above GENERAL ORDER :—

"Statement of the several Battles and Sieges enumerated in the Genl. Order, dated, H. Gds., 1 June. 1847, No. 582, at which Colonel Rice Jones was present, and for which a medal is claimed :—

Talavera ...	...27 and 28 July, 1809	Under the late Lt.-Col. Fletcher, Comdg. R. Engs. with the army in the Peninsula.
Busaco	27 Sept., 1810	
Albuhera	...16 May, 1811	
Ciudad Rodrigo ...	January, 1812	

R.J.

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REVIEW.

WITH THE VICTORIOUS BULGARIANS.

By Lieut. H. Wagner, War Correspondent of the *Reichpost.* (Constable & Co., Ltd.).

Lieut. Wagner's book, published an incredibly short time after the events it chronicles, does not profess to be a history of the Balkan War. Indeed, in the chapters dealing with the actual fighting he gives little more detail than was given in his famous despatches during the war. The interest of the book chiefly lies in the picture it gives of Bulgaria at this critical stage of its national existence. Since the modification by the Powers of the treaty of San Stefano in 1878 left a large portion of the territory the Bulgarians had regarded as their due, together with some thousands of their compatriots, under the Turkish yoke, war with Turkey has only been a question of time. To this end has the Bulgarian Army been trained, "for the attack only."

The Bulgarian plan of campaign was, roughly, to make for Constantinople with the largest possible force in the shortest possible time. The force available was reduced, firstly, by the necessity of investing Adrianople, secondly, by political reasons which rendered it advisable to send a considerable force further Westward into Macedonia to occupy the territory Bulgaria hoped to obtain for herself on the conclusion of peace. The 1st and 3rd armies on the East received no serious check until they arrived before the Chatalja lines, which were never attacked in force before the armistice was concluded at the end of November.

The possible breakdown of the peace negotiations does not seem to have occurred to Lieut. Wagner, who throughout his book appears to regard the war as at an end. He gives however an interesting forecast of the Bulgarian plans to force the Chatalja lines, by sending a force into the Gallipoli Peninsula to take the Dardanelles forts in rear and so open the strait to the Greek Navy, which might by gaining command of the Sea of Marmora render the southern flank of the Chatalja lines untenable and so enable the Bulgarians to obtain a lodgement there.

The book has the greatest possible interest at the present time, and bears singularly little trace of the haste with which it must have been prepared. This last remark unfortunately does not apply to the maps as they do not aid the reader much to follow the course of the campaign.

C.R.S.

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NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

BOMB-DROPPING FROM AIR CRAFT.

In the number for the 6th December, 1912, Capt. Stockhausen, staff officer of the Berlin Command, contributes a short article on the throwing of explosives from air craft. He draws attention to the report that although the Italians in the Italo-Turkish War achieved some good results in bomb-dropping at first, this success did not continue, and would therefore seem to have been due to luck. The official trials in Germany, Count Zeppelin's experiments, and trials in France have, however, distinctly shown that very accurate dropping is possible. Of course some practice is necessary and the Italians may not have had it; but this alone would not account for the Italian failures; the reason must be sought elsewhere. It may be taken for granted that, the Italians only flew by day and threw against living targets only.

A bomb dropped from an altitude of 500 metres (1,640 ft.) takes about 12 seconds to reach the earth. This would give an enemy who was on the look-out time to get out of the way. At first the Arabs did not understand bombs, but they soon learnt. In peace, of course, the inanimate targets used cannot move.

A bomb thrown from 1,640 ft. has a terminal velocity of about 100 metres (328 ft.) per second. The lateral effect of the fragments of the bomb is much reduced by this, for the proportion of their horizontal velocity to their vertical velocity is made very small. If the charge is increased to give more lateral effect, the bomb is merely blown into useless tiny fragments. It must further be noted that shells with percussion fuze that strike sand, water and deep snow either do not burst or have very little effect. It would therefore appear that human targets have little to fear by day from percussion bombs thrown from the air.

The use of shrapnel shell with time fuze would increase the chance of success but presents several serious difficulties. With a velocity of 328 ft. per second, acquired by a fall from 1,640 ft. altitude, the bullets would descend practically perpendicularly and the force of the explosion would hardly divert them from their vertical path. The bullet-swept zone must moreover always be a small one, and the nearer to the earth that the bomb bursts, the smaller it will be. Shrapnel can only be effective when its path is oblique to the surface of the earth and when it has been carefully tonged. Both conditions are impossible with shrapnel thrown from the air. Even an airship cannot remain over the same spot and throw bombs until the correct length of fuze is obtained. Shrapnel with time fuze cannot therefore be seriously considered.

The above considerations show why it was that the Italians effected so little with their bombs. The following several deductions can be drawn:—The best arrangements for bomb-throwing are little better

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than worthless: even by day effective practice can be made against human targets only under the most favourable circumstances: night at present is no friend of aeroplanes, but is more favourable than day to airships: the anxiety felt about French aeroplanes, so far as harming human targets, is exaggerated. Every soldier should be taught that bombs thrown from airships can be easily dodged.

No experiences as regards bomb-dropping on inanimate objects in the Italo-Turkish War are yet available. No effect can be expected, however, unless charges of from 160 to 220 lbs. of explosive are dropped. Aeroplanes are at once out of court, and nothing, whether it is of the rigid or semi-rigid type, can compete with the Zeppelin cruiser.

The article closes with paragraphs laudatory of the Zeppelin airship and an appeal to German patriotism to furnish the Count with more funds.

In the number of 19th December Capt. Stockhausen adds some remarks to his article of earlier date. He points out, that if airships are to attack live targets at all, they should select such as are not dangerous to themselves; for instance ammunition columns and trains. Amongst these they could at least cause panic.

As regards bomb-throwing on inanimate targets, he reiterates that it is only worth doing it from airships. He asserts that accurate dropping is possible and that a Zeppelin airship has actually thrown a charge of 600 k.g. (1,322 lbs.) from 1,000 metres (3,280 ft.), without the slightest harm to itself. This effectually disposes of any argument that it was impossible to drop big charges without shipwreck. He holds that against magazines, wharfs, troopships, pontoon bridges, etc., a charge of 75 to 100 k.g. (165 to 220 lbs.) will be ample.

Apparently unconvinced himself of the truth of the assertion that a charge of 1,322 lbs. has been thrown, he argues theoretically that there is no danger to the ship. If, he says, an ordinary balloon, filled with hydrogen, of 600 c.b.m. (784 cubic yards) contents drops a sack of ballast weighing 15 lbs., it rises about 100 metres (328 ft.) and the proportion of 15 to 600 is 1 to 40. But if an airship of 18,000 c.b.m. (23,544 cubic yards) drops 400 lbs., the proportion is only 400 to 18,000 or 1 to 45. The shock of the discharge is also less in comparison with the balloon, and becomes smaller as the capacity of the airship increases. Moreover an airship is unsuited to military purposes unless it can stand sudden variations of pressure. Of course the Zeppelin pattern can do so, even a wind of 10 metre-seconds (about 22½ miles an hour) is nothing to them.

The writer admits that airships are easier to hit than aeroplanes, but does not think that they should be given up on that account. They must avoid the danger by speed. He thinks unless a shell is exploded before it reaches the airship that it will do but little real harm, and that the greatest danger is from armed aircraft. However in this respect the Zeppelins can carry a heavier armament than any other type. Zeppelins, it is true, require enormous quantities of hydrogen, but German industry will have no difficulty in providing this at the right price and time. By paying a few halfpence more for coal gas in peace, Germany would

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enable the private firms which make gas to extend their plant to manufacture hydrogen! The article like the former one concludes with a puff of the Zeppelin airships.

AIRPLANES *versus* AIRSHIPS.

In the number for the 7th December, 1912, special attention is drawn to the article "France and Germany: Our Aeroplanes—their Airships," which appeared in *France Militaire*, No. 8707, of 10th/11th November, 1912. In this M. Veillat, a member of the Aviation Committee of the Chamber of Deputies, pointed out that although France had an advantage as regards aeroplanes, yet these could not compete with the Zeppelins in flying by night, in radius of action, or in power of carrying explosives. Airships could bombard towns and fortresses, destroy railway bridges and troop trains, and fight warships. Therefore means of combating them must be devised.

GERMAN NATIONAL AVIATION FUND.

It is stated in the 1st January number that 7¼ million marks (£362,500) have been subscribed to the National Aviation Fund by the German public. The Committee propose to spend £53,000 on the purchase of military air craft, which are to bear the names of the subscribing towns and provinces; and £28,850 for experimental purposes (the Reichstag recently refused a credit of £10,000 for the purpose). The balance, some £280,000, is to be used for training and insuring airmen.

"E."

REVUE MILITAIRE SUISSE.

December, 1912.

MILITARY AVIATION.

Some account of recent developments in various countries.

France.—A national subscription was opened and applied to various purposes, including landing places in the North and East. 70 pilots have been trained, 55 more are required, also 30 more stations. A short description of the conditions and results at the meeting at Rheims in October, 1911, is given, also of the Act of 29th March, 1912, fixing the organization of the Military Flying Corps. The strength of the corps at the end of 1912 is given, and the stations of the various groups and schools. Some remarks are made on the tactical employment of aeroplanes.

Germany.—The *Deutscher Luftfahrer Verband* is calling for a public subscription of 6,850,000 marks, of which 2½ millions are to subsidize the industry, as outside the Army and Navy there is no demand for air craft. 2½ millions will be required yearly for some time to form stations about 100 kilometres apart, to popularize flying as a sport. Other efforts, public and private, are described.

Austria.—Over 1,200,000 francs were voted in 1911 and in 1912 a subscription was called for. Some figures as to the numbers and pay of officers are given. A volunteer corps has also been formed. The con-

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ditions of the military aviation meeting at Fischamond are described. The annual budget is 440,000 crowns.

Italy.—The King has given an important donation, 1,000,000 lire were raised by subscription, and 500,000 lire were allotted by the Minister for War. It was decided in 1912 to purchase apparatus to the amount of 2,000,000 lire. The expeditionary force in Tripoli had 23 aeroplanes and 34 pilots. A battalion of specialists has been formed, the tests for entry to which are severe.

Belgium.—In 1910 a school of aviation was formed at Braeschart. The budget for 1913 includes large sums for aviation, including 1,000,000 francs for continuing and perfecting experiments.

Russia has opened a subscription and 2,480,000 francs, collected during the Russo-Japanese War for the fleet, has been devoted to aviation. A school of airmen was opened in 1910 and furnished 20 pilots for the manœuvres in 1911. At the end of 1912, 100 officers should have certificates.

Bulgaria has used aeroplanes during the War in the Balkans.

It is calculated that in March last France had 450 pilots and 500 aeroplanes, Germany 140 pilots and 150 aeroplanes, and in September the latter had 391 officer pilots and 244 apparatus. Austria now has 85 pilots and 55 aeroplanes.

Some remarks are then given on the military employment of aeroplanes, and methods of concealing troops from sight from them.

More about Krupp's Works.

An article to supplement the account given in the number for September, 1912. Good photographs are published of the first muzzle-loading guns made of cast steel, and of the first breechloaders made by this firm.

The War in the Balkans.

In continuation of the article in the November number, an account is given of the operations of the Montenegrin Army, and the country through which it advanced from the 8th October, when war was declared against Turkey up to the 7th November, 1912, including the investment of Scutari. No descriptions of the battles, or details of tactics, are given.

January, 1913.

Notes on Guarding the Lines of Communication.

A sketch is given of the objects of the line of communications, of the necessity for securing these objects, and of the means for doing so adopted in the Swiss Army. Two instances are then given from the War of 1870–71 describing in detail circumstances which actually occurred at posts on the L. of C., viz.: the surprise by the French of the post at Stenay, and the destruction of the bridge at Fontenoy. Lessons are deduced from these two engagements, which are worthy of study.

Regulations for Sanitary Services.

Extracts from and criticisms of the new Swiss Regulations for Medical and Sanitary Services in Peace and War, based on reports received on the wars in South Africa and Manchuria. Chapters 1 and 2 are reviewed. The article is to be continued.

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THE "DEPORT" GUN IN ITALY.

Rapidity of fire, precision, and powerful effect are attributes common to all modern artillery, and further progress in these respects can hardly be secured at present. Increase in the field of action and more perfect adaptation to modern tactics are, however, still required, and have been the aim of Colonel Deport. It should be possible to increase the horizontal field of fire without having to move the carriage, and, also, in broken country where the angles of sites may vary considerably, to ensure large angles of elevation and depression being obtainable. Shortly, by splitting the trail into two portions, and so providing four points of support for the carriage, a horizontal angle of fire of 54 degrees can be obtained without moving the carriage. By cranking the axle of the carriage the gun can be elevated to 60 degrees, from 10 degrees of depression. The arrangements for checking the recoil are very ingenious. The opening and closing of the breech is semi-automatic. Clear descriptions, with diagrams and photographs, are given, and the methods provided for laying are explained. Only four gun numbers are normally required. Some remarks follow on possibilities of failure in Deport's system, but these are all controverted. The fact remains that the Italian Government has tried the gun and carriage against those of Schneider and Krupp, and has chosen the Deport. The tactical possibilities of the weapon are then brought under review, and a discussion ensues on the probable use of such guns, firing at high elevations for curved fire, in lieu of mortars which may, or may not be, at hand when required. This would entail another cartridge with a reduced charge of quick-burning powder, but would enable its own attacking infantry to be supported right through their advance to the delivery of the final assault.

THE MANŒUVRES OF THE 4TH DIVISION IN 1912.

A short account of these operations with certain remarks, favourable and otherwise.

A. R. REYNOLDS.

RIVISTA DI ARTIGLIERIA E GENIO.

October, 1912.

THE INFLUENCE OF RECENT TECHNICAL INVENTIONS ON MILITARY OPERATIONS.

An article by Major Cardona of the Engineers in the October number of this Journal, on the influence of recent technical inventions on military operations, contains many valuable ideas and is of much interest. The successive scientific inventions applied to military art have produced, especially during the last half century, an evolution in the conduct of military operations, felt as much in modern armies as in those of 1866. The author proceeds to examine the result of these influences on strategy and tactics.

Influence on Strategic Operations.—The first point to notice is how the increasing size of modern armies (produced by new politico-social conditions), together with the perfection of new weapons, has created an enormous extension of battle fronts. This has led to a most difficult

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strategical problem, viz. the handling of a large and extended force so as to ensure that the blow should be directed at the right point and with the greatest celerity at an opportune moment. If the strategy of the XXth century had only the same technical means at its disposal as it had in the times of Moltke, the conduct of the armies of to-day would be exceedingly difficult and risky. But, fortunately, useful and quick means of transmission—telegraph and field telephones and especially wireless telegraphy—have come to our aid, and dirigibles and aeroplanes provide a more powerful and speedier means of reconnaissance. Automobiles and motor cars also allow of a more rapid and convenient means of transport. All this technical progress tends to abolish "distance" and to gain time. A study of the mobilization of armies of to-day, their movements, their manœuvres and their actual armed life, as contrasted with that of 1870, convinces us of the advantages of the modern improvements in the field of strategy.

Mobilization of Armies.—The mobilization of armies is based upon the maximum carrying power of the railways, and is an operation of such importance that every effort should be made to shorten it by their perfect military organization. Even in Germany in 1870, the railways could not keep pace with the exigencies of the war, whilst in France they were totally inadequate. So grave were the inconveniences caused by the military employment of the railways during the mobilization of the French Army, that it was impeded and surprised by the German Army. The latter was able to complete the concentration of its army in three weeks, and this was an unexpected result as it had taken seven weeks to do so during the Prussian mobilization in 1865. To-day it can be further greatly accelerated owing to the increased power of modern locomotives. The abundant supply of automobiles must, moreover, be taken into account, as they may be substituted for ordinary carriages, and thus not only accelerate the actual mobilization but also remove part of the strain from the railways. Everyone knows that the rapid mobilization of an army is of the greatest advantage, as it may render a strategic surprise possible. General Von Blume was right in saying that the way mobilization is carried out is a sign of the grade of civilization of a country, of the spirit of its population, and of the vigour of the organization of the State. During the concentration of the troops the most important duty is to ascertain promptly when, where, and how the enemy's masses are concentrated, and to hamper the operations as far as possible by exploding bombs at their railway stations, especially from dirigibles, etc. For this reason the dominion of the air is likely to become as important as that of the sea. In aerial warfare the rapid aeroplane will probably be an adversary more to be dreaded than the dirigible. It cannot be expected that the efficacy of fire from special cannon fired at great angles of elevation, can be such as to greatly embarrass the enemy's dirigibles, which move at a great velocity and continually change their course.

Armies on the March.—The armies of 1870 were generally composed of a number of army corps, as is the case to-day, but each army corps had only two divisions, while to-day there are three. The notable increase of artillery and wagons shows also that an army occupies on the march a

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much greater depth than that of 1870. The difficulties in the movements of armies are to-day greatly increased by the remarkable increase in the size of armies. But fortunately new aids to strategy have appeared in the special and technical means of rapid transmission. In fact the telegraphic and telephonic communication of the present day allow of a completer control of the larger bodies of men than was possible with the smaller forces in past times. The use of the telegraph clearly shows this by the way in which movements of expansion and concentration of troops, ordered from the supreme command, can be guaranteed.

Strategical Manœuvres.—When considering the employment of armies in strategical manœuvres, working on either external or internal lines, we must remember that, were it not for the rapid technical means of transmission (the telegraph and wireless telegraphy) and for transport (the automobile), the attack of the wings, or the frontal attack, the reinforcement, or other developments would be rendered too difficult for the commander, owing to the increased extension of the battle front. Even with these, for this reason, it is impossible to inform the commander, by means of the advanced reconnoitring cavalry, of all that is taking place in front, and it is necessary therefore for him to receive notice of the enemy's movements by means of aeroplanes and dirigibles. As soon as the aeronautical service becomes regularly developed, and the airships perfected with wireless telegraphy on board, strategical manœuvres will be of little danger to a forewarned adversary. Also aeronautical science will assist in preventing the rapid concentration of the enemy rendered possible by the telegraph. For example if the Austrian Army at Sadowa had possessed a single balloon it would certainly not have been surprised. To-day, when the front of an army is four times what it was in 1870, it will be still more difficult to execute strategical manœuvres by bringing up the reserves. But at the same time the military organization of the railways will allow of whole army corps being moved rapidly from one point to another, and, if no railway is available, the employment of motors will enable the General to adopt the necessary movements for counteracting those of his enemy.

Reinforcements.—When bringing up reinforcements, especially in urgent and critical cases (such as during and after a battle, in the pursuit or retirement), the new means of transport by motors will be of immense advantage. A motor of medium size has a radius of action of about 200 k.m. daily and can carry 2 tons, while an ordinary horse wagon has only a radius of action of 32 k.m. daily and can carry 1 ton, so that the motor has a radius of action six times as great as that of the ordinary horse wagon. Its greater rapidity of bringing up reinforcements also, especially after a battle, will be of the greatest advantage and will bring a powerful influence to bear on the subsequent tactics. In fact the the motor, acting as a mobile railway, will help to increase the liberty of action of the commander-in-chief, and will give the troops greater rapidity of movement, so that the army corps will be less tied by their communications. For this reason the communications of an army dependent upon motor traction will be less vulnerable to the enemy's attack than those depending on the railways.

E. T. THACKERAY.

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CORRESPONDENCE.

THE INTERNATIONAL MAP OF THE WORLD.

SIR,

I have read, with some interest and no small amount of disagreement, the account of a lecture, by my friend Mr. A. R. Hinks, on the International Map of the World. The lecture was published in the February number of the *R.E. Journal*, and I should be obliged if you would print the following comments on it. I will make them as brief as possible.

It will clear the ground to mention, in the first instance, those Resolutions of the International Map Committee which meet with Mr. Hinks's approval. They are those dealing with the adoption of the metre as the unit of height, the styles of lettering, the rules for the spelling of place-names, the use of contours as the basis of the precise representation of the relief, and, I believe I may add, the projection.

There is another Resolution which he appears, as far as I can judge, to condemn, a Resolution which has been affirmed by more than one International Geographical Congress and has not hitherto been questioned, namely, the division of the world's surface into a regular network of sheets bounded by meridians and parallels, reckoning from the meridian of Greenwich and the Equator, respectively. It is however hard to see what could be conveniently substituted for this system. As to breaking the margins, in cases where it may be thought desirable, there is nothing in the Resolutions to prevent this being done.

I will pass over the criticism on the want of uniformity in the selection of layer tints in the five published maps dealt with, only remarking that the variations appear to me to be within the four corners of the regulations, and that the Committee recognized the necessity of allowing a certain latitude in this, as in other matters.

I now come to a statement which appears to me to be entirely incorrect, namely, "there can be no question that in mountainous country, even in the not very formidable mountains of the Highlands, the layer system is a complete failure for one-millionth maps." No! The layer system is not a failure in such regions. I have compared the one-millionth layer map of the Highlands with its predecessor, the hill-shaded map, and have no doubt whatever that the information conveyed by the former is not only far more exact but far more graphic. The layer system is in fact the only system at present devised which shows relative heights clearly.

That there is a difficulty, on any known system, in representing an extensive high plateau is a cartographical truism of which I willingly make Mr. Hinks a present, but when he attempts to prove that it is

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impossible to represent a mountainous country satisfactorily by layers, then, I think, he both fails in the proof and is contradicted by experience. One would think that no mountainous country had ever before been represented in this way on small scales. Of course we all know to the contrary, for, after all, layer maps have been in use for three-quarters of a century. But perhaps what he has in mind is the necessity of choosing a suitable layer interval, and, in this respect, the International Resolutions give ample latitude.

In fact all through his criticism he misses the point that the Resolutions do allow a very wide discretion; for instance, great latitude is allowed in the selection of the contour intervals, the layer tints may be at the top or bottom of the intervals, editions may be published which do not make use of layer tints and so on.

The proof of the pudding is in the eating and I do not hesitate to say that the International system has been a success as applied to the Highlands of Scotland, and I am fortified by high authority in the opinion that it was wise to adopt this method. This is not, of course, to suggest that better systems may not be invented in the future. That, the future alone can show.

I have recently seen three sheets published by the Geographical Service of the Argentine Army. They are excellent examples of the International series and, with those sheets issued by the United States Geological Survey, and those which are being produced by Hungary, Italy and Spain, and the British and French sheets, will no doubt be exhibited at the International Geographical Congress which is to be held at Rome at the end of March next. I should mention that the French Government is devoting considerable funds to the systematic execution on the International system of the one-millionth maps of France and French Northern Africa.*

I am sorry that Mr. Hinks does not like the scheme, but am consoled by the reflection that the International Committee which drew it up was a competent and thoroughly representative body, and that it is not possible in any human undertaking to satisfy everybody.

In conclusion let me quote a remark from an account in the *Bulletin* of the American Geographical Society† of the progress of the United States sheets of this series: "Many of the valuable features of the map are due to the excellent requirements of the International agreement (mainly, let it be repeated, the one making obligatory the representation of relief by hypsometric coloring) which cannot but guarantee its high geographic quality."

C. F. CLOSE,
Colonel.

Ordnance Survey Office, Southampton, 10th February, 1913.

The Editor, *R.E. Journal.*

* Since writing the above paragraph I have received from the *Oficina de Mensura de Sierras*, Santiago, four very interesting provisional impressions of the sheets of the International map of Chile.

† Vol. XLIV., No. 11, 1912.

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RECENT PUBLICATIONS OF MILITARY INTEREST.

REVIEW OF BOOKS.

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FOREIGN ARMIES.

THE RUSSIAN OFFICER'S FIELD SERVICE POCKET BOOK. By Colonels Vitsnuda, Trotski, Pnevski, Imnadze of the Russian General Staff. 5th edition. 463 pp. Illustrated with numerous sketches and diagrams. 8vo. Vilna, 1912. Military District Press. 3s. 4d.

In the opening chapter of this book concise particulars are given of the organization of the Russian Army Corps, and cavalry division, the service of communication, march tables, the principles of appreciating the situation, writing orders, rendering reports, and preparing sketches. A chapter of 70 pages is devoted to fieldworks, demolitions, and railways; another of 122 pages to the tactics of the three arms and reconnaissance; other chapters deal with combined operations (140 pp.), line of communication services, and give a short account of naval organization and operations. Manœuvres and umpiring occupy 11 pages. The work has been carefully compiled and statements are substantiated by reference to the relative Army Orders. Large print is used for the chief matter, small print for lesser detail; abbreviations are freely employed. The book is an encyclopædia of information, and can be recommended. It must be admitted, however, that like many military pocket books it is bulky; it weighs 1 lb. and requires a capacious pocket to hold it; thinner paper might have been used with advantage.

HISTORY.

1870. By Lieut.-Colonel Ernest Picard, Chief of the Historical Section of the French General Staff. In five volumes, each of about 350 pp., with maps. 8vo. Paris, 1907–12. Librairie Plon. 4s. each volume.

The majority of officers will probably have read this valuable work, the first volume of which appeared as long ago as 1906, but those who have not studied it are strongly recommended to do so as soon as possible. The author's style of writing is charmingly simple and at the same time very forcible, while his facts, in view of his official position, must be considered unimpeachable. The work, which is a collection of papers published from time to time in the official organ of the French General Staff (*La Revue d'Histoire*), consists of the following five volumes:—

Volume 1.—The loss of Alsace.

Volumes 2 and 3.—The War in Lorraine.

Volumes 4 and 5.—Sedan.

The object of the author is not so much to describe the various details of the fighting as to enquire into the causes of the French disasters and to bring out the lessons to be learnt from them, whilst at the same time endeavouring to follow what was in the minds of the commanders and to discover why they acted as they did.

Volume 1 deals with the events from the commencement of the war up to the Battle of Wörth (inclusive). An interesting description is given of the personal qualities of the principal French generals and their staff officers, and the author points out that, whilst important commands were given to Bourbaki, Felin, Douay, de Failly, and Frossard, because they were favourites at Court, such excellent soldiers as Palikao and Trochu were not employed with the army of the Rhine at the commencement of operations, because they did not shine in society. Writing of the engagement of Saarbrucken, Colonel Picard considers

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that the 2nd, 3rd, 4th, and 5th French Corps should, on August 2nd, have advanced on Saarguemines, Saarbrucken, and Volklingen, and that the Guard Corps should have been left at Saarlouis, at which point the Germans were expected to cross the frontier. Had this been done, Colonel Picard thinks that the impatient Steinmetz would certainly have hurried forward and attacked the French, with the result that four French Corps would have had only the 1st German Army to deal with. It is claimed that a French offensive movement across the Saar on August 2nd would have had the additional result of causing the 2nd German Army to halt. The grounds for this contention are that the orders to this Army laid down that if the enemy took the offensive, the 2nd Army was not to move forward, but was to "concentrate to the east of the mountains and accept battle there."

As regards the action at Weissenberg, the French Staff is severely criticized for having sent Abel Douay there without definite orders as to what was expected of him; whilst Douay himself and his successor Pellé are condemned for attempting a fight to a finish when a delaying action and a subsequent retirement were clearly indicated as the proper course of action. After giving a singularly clear account of the Battle of Wörth, Colonel Picard adds: "A study of all the documents connected with the operations of August 5th and 6th has convinced me that if General de Failly had done his duty and had complied with the orders given him by Marshal MacMahon, instead of allowing himself to be put off by unimportant topographical considerations which will not bear examination, at least two divisions of the 5th Corps and its reserve artillery could have been assembled at Reichshoffen at 1 p.m. on the 6th August, at the disposal of the Commander of Alsace." Had this happened it is considered that MacMahon would undoubtedly have been able to hold his own at Wörth.

After discussing the question as to who was responsible for the disaster at Wörth, Colonel Picard comes to the conclusion that both de Failly and MacMahon were to blame for it; the former because he refused to respond to MacMahon's urgent appeals for help and disobeyed orders; the latter because he accepted battle without having first concentrated his forces.

The second volume deals with the events from the Battle of Spicheren to the Battle of Borny (both inclusive). Having pointed out the defects in the position occupied by Frossard at Spicheren, and having described the battle with admirable lucidity, Colonel Picard proceeds to enquire into the causes of the French defeat. He has no hesitation in saying that the responsibility for the disaster must be assigned to Bazaine, whom he severely criticizes in the first place for not proceeding to Spicheren himself as soon as he heard that a battle was going on there. He adds further: "Instead of ordering the whole of the forces at his disposal to march at once to the battlefield, Marshal Bazaine left the divisions of Montaudon and Castagny to their own devices; he gave Metman's Division a purely defensive *rôle;* he immobilized Decaen's Division and the reserve artillery of the 3rd Corps at St. Avold for the purpose of guarding a position which no one was attacking. Now Bazaine might have ordered all his troops to march to the sound of the guns before 2 p.m. Had he done this they would have arrived on the scene between 5.30 and 6 p.m., and it is probable that the battle would have ended in a victory for the French Army."

Pages 169 to 180 contain the author's views regarding Bazaine's character as a soldier and a man. It will suffice to say that there is hardly an opprobrious adjective in the French language which is not applied to the unfortunate Marshal.

After describing the engagement at Borny, Colonel Picard tells us that French Headquarters were much pleased with the result of the action, and that when, some hours after the termination of the fight, Bazaine went to make his report to the Emperor, he was received by the Imperial suite with "manifestations of great joy."

Apparently, however, the rank and file did not gain much confidence either in themselves or in their generals as the result of the fight at Borny, for it is evident from the author's description of Bazaine's army when it reached Metz subsequently that the *moral* of the men was at rather a low ebb.

Volume 3 opens at the Battle of Rezonville, and concludes with an account of the Battle of St. Privat.

Discussing the Battle of Rezonville, Colonel Picard refuses to accept von Moltke's view that it was a German victory, but claims that it was indecisive. The strategical result of the battle was unfavourable to the French in that the presence of hostile forces about Trouville prevented them from using the road to Verdun by Mars-la-Tour without fighting again. On the other hand, however, the French were at perfect liberty to move by Etain or Briey. The author agrees with the criticisms which have usually been made with regard to Bazaine's action in reinforcing his left instead of strengthening his right during the battle. Summing up his

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views regarding the operations in Lorraine, which ended with the withdrawal of Bazaine into Metz, Colonel Picard comes to the following conclusions :—

(*a*). In spite of all statements to the contrary, Moltke had no original intentions of bringing about the situation which existed when Bazaine retired into Metz.

(*b*). The tactics of the Germans were by no means sound in many instances, and the French had a number of opportunities of inflicting serious reverses on the enemy which were lost owing to the total incapacity of the higher leaders in the French Army.

Volumes 4 and 5, which deal with the events connected with the drama of Sedan, are exceedingly interesting reading. In assigning the blame for this disaster, Colonel Picard considers that the responsible persons were :—

(*a*). The Empress, who was obsessed with the idea of keeping the Emperor away from the capital.

(*b*). The War Minister for having an insufficiently considered plan and for insisting on MacMahon carrying it out to the letter.

(*c*). Marshal MacMahon for his weakness in attempting to carry out a plan which he knew to be hopelessly unsound.

(*d*). General Wimpffen for insisting on taking over command after MacMahon was wounded and not carrying out General Ducrot's plan, which, if adopted, might have saved the French Army from capitulation.

China's Revolution, 1911–1912; a Historical and Political Record of the Civil War. By Edwin J. Dingle. 298 pp., with two maps. 8vo. London, 1912. T. Fisher Unwin. 15s.

Mr. Dingle is a journalist who has travelled extensively in China. He was present at Hankow at the time of the outbreak of the Revolution on October 10th, 1911, and remained there until the Peace Conference was opened at Shanghai on December 18th, 1911.

The account of the operations near Hankow and Han-Yang (pp. 57 to 150) is the most interesting part from a military point of view, and is the only portion with which this review deals. The author pays a high tribute to the fighting qualities of the Chinese soldier. His opinions are expressed in somewhat exaggerated terms, but they are valuable as being those of an eye-witness, and are shared by other foreign observers.

Of the Battle of Kilometre Ten, he says: "Here fighting was being carried on with a pluck which astonished all beholders. The Imperial Army was, for the first time since the Chinese Model Army had been organized, plunged into real warfare. The Revolutionaries were for the most part raw recruits, but their bravery would have made many an occidental regiment blush with envy." Of the Northern Army he says that "there were none but highly trained men in whom were instilled strongly the absorbing lessons of the Army. They knew nothing else. They did nothing else. They were fighting machines. . . . There are certain great weaknesses in Chinese military organization which have to be removed, but the Northern Army founded by Yüan Shih-kai himself. . . . had the minimum of these defects."

The transport and medical services of the Northern Army were, however, woefully defective, and, had the peace negotiations failed, it is most improbable that the Imperialists, setting aside the question of their loyalty to the Throne, would have been able to undertake a prolonged campaign. The lesson of this brief struggle is that, if financial difficulties can be overcome, the organizing power of Yüan Shih-kai will produce an army from this material which no Power can afford to despise.

The actual events seen by the author are very graphically described, but the vast area over which the operations were spread naturally renders difficult a complete account of the Revolution. The operations around Nanking, and General Chang-Hsün's retreat up the Tientsin-Pu-k'ou Railway are very briefly dismissed. No mention is made of the fighting on the Shan-Hsi Railway, which, by threatening the communications between Peking and Hankow, rendered the situation of the former place for a time very precarious.

An event exercising a powerful influence on the course of the Revolution, and one of which the author has lost sight, was the action of General Chang Shao-Tseng in North-East Chih-li at the end of October, 1911. General Chang was in command of the 40th Brigade, which had been ordered from Mukden to the assistance of the dynasty. His ultimatum to the Throne had a remarkable effect on the Imperial attitude towards the revolutionary movement, and was the precursor of Yüan Shih-kai's return to political life.

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Mr. Dingle has had access to correspondence between Li Yüan-hung and Yüan Shih-kai, and to letters addressed to Admiral Sa by the young China party at Wu-Chang. These throw interesting light upon the indecision existing in the minds of the chief actors in the Revolution. This indecision was reflected in the conduct of operations and in the lack of confidence on the part of the men in their leaders.

WELLINGTON'S ARMY. By C. W. C. Oman. 395 pp., with index, illustrated. 8vo. London, 1912. Edward Arnold. 7s. 6d.

Our warmest thanks are due to Mr. Oman for this most interesting volume concerning Wellington and his Peninsular Army. To most people it will be found to contain much that is new concerning its organization, daily life, and psychology, and yet to understand what these men accomplished a knowledge of these and similar details is really essential. The author devotes a chapter to enumerating and commenting on the sources to which the student may turn for information about the Peninsular War. The numerous diaries and records that exist on this subject will come as a surprise to most people.

The following three chapters deal with Wellington as a leader of men, as a strategist, and as a tactician. The limitations of his heart are fearlessly exposed, while at the same time the fullest credit is given to those wonderful powers of brain which enabled him to be his own chief of the staff as well as to handle delicate diplomatic questions with almost unvarying success. The organization of the army is then examined and explained. Its headquarters, its brigades and divisions, its regiments, its officers, and its men are dealt with in turn. From a study of these chapters we are able to obtain a view of the system of staff duties which obtained in the army and of the grouping which its units assumed as the war progressed.

Another chapter deals with the auxiliaries, the Germans and the Portuguese, who rendered such valuable assistance, the former from the commencement of the struggle, the latter from the time when the reorganization, carried out by Marshal Beresford, had taken effect.

Mr. Oman devotes further chapters to such matters as Discipline and Courts-Martial, The Army on the March, Impedimenta, Sieges, Uniforms and Weapons, and the Commissariat, on all of which questions he has amassed a store of deeply interesting information. It is impossible in so short a review of this nature to deal adequately with such a work as Mr. Oman has here given us. We advise all those who take an interest in Wellington and his army to make a point of obtaining a copy and reading it for themselves.

A MEMOIR OF THE KHANDESH BHIL CORPS, 1825—1891. By A. H. A. Simcox, I.C.S. 281 pp., with 5 illustrations and 1 map. 8vo. Bombay, 1912. Thacker & Co., Ltd. 9s.

An interesting account of the raising and working of the parent of Indian Local Corps. The narrative has been compiled largely from Government records, and original despatches are freely quoted. Those written by Lieut. J. Outram (afterwards Lieut.-General Sir J. Outram), who raised the corps and commanded it for 10 years, are of especial interest.

Although the book will commend itself more to those who are interested in Khandesh and the Bhils than to the general reader, yet its pages will repay perusal by those who wish to find exemplified the principles which underlie the proper employment of local corps.

STONEWALL JACKSON'S CAMPAIGN IN THE SHENANDOAH VALLEY OF VIRGINIA FROM 4TH NOVEMBER, 1861, TO 17TH JUNE, 1862. By William Allan. 284 pp., and 8 maps. 8vo. London, 1912. Hugh Rees. 6s.

This is a reprint of the valuable work published in 1880 by the late Lieut.-Colonel Allan of the Staff of the Second Corps of the Army of Northern Virginia. It covers General Jackson's career from the Romney Expedition in the winter of 1861 until he left the Valley in June, 1862, to take part in the seven days' battle in the Yorktown Peninsula.

POLITICS.

THE CONDUCT OF WAR. (La direction de la Guerre). By Commandant V. Dupuis. 367 pp., with a map to illustrate the operations on the Loire. Paris, 1912. Chapelot. 4s. 9d.

The author of this interesting and ably written work belongs to the Historical Section of the French General Staff and has already carried off one of the most coveted prizes of the French Academy as a result of his literary ability. The object of his present book is to consider the

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all-important question as to how far the Government of a country is justified in interfering in the conduct of military operations carried on by its soldiers. The first part of the book, which deals with "The liberty of action of Commanders-in-Chief," describes various operations during the Revolution, the Reign of Terror, the Directory, the Consulate, and the first and second Empires, with a view to show how far the military commander was allowed freedom of action and how far he was fettered by political considerations. In the second portion of the book the author gives his views as to the relations which should exist in time of war between a Commander-in-Chief and his Government. He considers that experience and common sense indicate that it is impossible to separate politics from the conduct of war, and that in all warlike operations, not only the soldiers and the Government, but also the diplomat must have a share of responsibility. In time of peace the Government provides the means for making war, the diplomat completes the work of the Government by arranging alliances, and the soldier considers how the means placed at his disposal can best be utilized if war breaks out. During peace the Government and the diplomat are much in evidence, but the soldier does not appear on the scene. When hostilities commence, however, the state of affairs is quite different. Just as the fireman at the theatre remains out of sight at ordinary times, but becomes the principal figure when fire breaks out, so the soldier, on the outbreak of war, emerges from obscurity and has all eyes turned on him.

Discussing the method of conducting war in the case of monarchies and empires, the author says that it is only natural that the head of the State should be anxious as to the outcome of war, because the stability of his throne often depends on the result of the operations. This anxiety naturally induces the head of the State to interfere in the conduct of the war, especially if things are going wrong. The result of such interference varies in accordance with the military capacity of the monarch, and since it is rare to find a thoroughly capable soldier at the head of a State, Commandant Dupuis comes to the conclusion that it is a mistake for a monarch to interfere actively in military operations. He points out, however, that there are exceptions to this rule. For example, in the Franco-German War the King of Prussia on one occasion intervened most opportunely. It will be remembered that at the end of November, 1870, there was a violent difference of opinion at German Headquarters as to whether the correct course of action was to concentrate all energies on the bombardment of Paris or on the defeat of the Army of the Loire. The King of Prussia decided the dispute by ordering immediate operations against the Army of the Loire.

Writing of the conduct of war in the case of a republic, the author makes the somewhat curious suggestion that Army Headquarters should be accompanied by delegates from the Government, and that they should consult with the Commander-in-Chief as to how the operations are to be carried on. Commandant Dupuis claims that had this been done in 1870-71 much friction between the civil and military authorities would have been avoided.

Although the views of the author will not be generally accepted by soldiers, the book is so well written and the arguments in it are so clearly put forward that the reader cannot fail to be interested.

AWAKE, YOU BRITISHERS, TO YOUR PERIL FROM OVER-THE-WAY AND HASTEN TO FACE IT. By Colonel Sir Lonsdale Hale. 23 pp. 8vo. London, 1912. Love & Malcomson. 2d.

This pamphlet is based on four articles which appeared during the course of the past summer in the *People*. Its object is to arouse the nation generally to the peril in which it stands at the present time as regards "National Defence." This peril is, the author points out, twofold, including both loss of independence and loss of position.

The remedy lies with the nation itself, and equally concerns every class of the community. No political party will, however, adopt the measures advocated unless and until it is plainly shown that it is the wish of the majority of the people. Sir Lonsdale Hale, therefore, appeals to the voters at large to examine the question carefully and seriously, and to avoid making it a party question. It is to be hoped that this pamphlet will be widely and generally read.

THE STRANGLING OF PERSIA. By W. Morgan Shuster. 367 pp., with 85 illustrations, map, introduction, index, and 6 appendices. 8vo. London, 1912. Fisher Unwin. 12s. 6d.

While opinions will differ on many points in Mr. Shuster's narrative, deductions, and expressed opinions, and while allowances must be made for the circumstances connected with

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its publication, this book is one full of interest, especially at the present juncture, and will repay careful perusal.

In the Introduction the course of events leading up to the appointment of the American financial experts in Persia in 1911 is outlined.

Chapters I. to VIII. deal with affairs in and connected with Persia during Mr. Shuster's tenure of his appointment as Treasurer-General.

In Chapters IX. and X. Mr. Shuster gives his opinions on the character of Persian officials and people, and of European politics as bearing on Persia.

In Chapter XI. Mr. Shuster deals with the plans for reorganization of the Persian finances.

METHOD IN THE STUDY OF STRATEGY. (La méthode dans l'étude de la stratégie). By Colonel Cordonnier, of the 119th Infantry Regiment. 46 pp. 8vo. Paris, 1912. Lavauzelle. 10d.

The author of this interesting little pamphlet was formerly a professor at the French Staff College, and has recently made a name for himself by the publication of the first volume of his book entitled "The Japanese in Manchuria, 1904." Colonel Cordonnier urges that there is a complete want of proper system in the study of strategy, and holds that it is of vital importance for an army to have a sound strategical doctrine. He insists that the doctrine must be sound, otherwise he considers that it is better for an army to have no strategical doctrine at all. The first step towards the founding of a sound strategical doctrine must, in the author's opinion, be a very close and exhaustive study of military history. Cursory perusal of a number of campaigns is practically valueless.

The next point brought forward by Colonel Cordonnier is that strategy should be taught on the ground and not in the lecture hall. Further, he lays great stress on the necessity for imbuing the whole army with the strategical doctrine which, after profound study, has been accepted by its chiefs.

As an example of the lack of study of the strategical lessons to be learned from history, Colonel Cordonnier quotes the action taken by the French when they were some years ago threatened by war simultaneously on their North-Eastern and Alpine frontiers. Had the lessons of 1866 been taken to heart the French would have held the comparatively unimportant frontier of the Alps with their Territorial troops, and would have massed all their best troops at the vital point—the North-Eastern frontier. Instead of doing this, picked troops (the chasseurs alpins) were used on the Alpine frontier, and one of the best generals in the French Army was placed in command there.

To show the results of having an army without a thorough knowledge of sound strategical doctrine, Colonel Cordonnier quotes the operations on the Yalu. Kuropatkin wished to gain time for the arrival of reinforcements, and he accordingly ordered the commander of the Russian detachment on the Yalu to delay the Japanese by fighting a series of rearguard actions. The reply of the Russian detachment commander to this order was: "The Emperor has made me a knight of St. George, and I will not retreat."

GERMAN AND ENGLISH TACTICS. (Deutsche und englische Taktik). By E. von Estorff. 93 pp., with six sketch maps in the text. 8vo. Berlin, 1912. E. S. Mittler und Sohn. 3s.

Recent events have led people in Germany to pay more attention to the British Army and its tactics than they have done heretofore. Both the German and British Armies have submitted their tactical creeds and regulations to a searching criticism and corrections since the Manchurian War.

The author points out and compares these alterations in his book using as specimens of British tactics as they were, the employment of troops in various battles of the South African War, and indicating how mistakes then made are combated in the latest text books.

His closing sentence is illuminating:—

> "However efficient the British Regular Army may have become, its numerical weakness renders it scarcely worthy of consideration in an European War; and the value of the Home Defence Force, the Territorial Army, will always remain questionable."

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AN EXTEMPORISED HAND GRENADE.

By Bt. Major R. L. McClintock, d.s.o., R.E.

The hand grenade is a military appliance which, albeit of oft and well-proven utility in both savage and civilized warfare, is specially prone to oblivion during any protracted spell of peace. To the ordinary range-bred soldier it naturally seems incredible that men armed with magazine rifles should ever either desire, or be, in a position to hurl bombs at each other by hand. So, between wars, the use of grenades receives scant attention, and the fruits of laboriously acquired experience are thus gradually lost. Sooner or later, however, the need for the employment of this weapon once more arises, and a suitable type has forthwith to be re-discovered at the expense of much time and trouble.

Hand grenades are essentially articles which lend themselves to improvisation. The opportunities for their use are so rare, and they are so weighty, bulky and so costly as compared with rifle ammunition, that carting them about with an army in the field would seldom be worth while. They are accordingly most unlikely to be found on the spot when suddenly required.

The remedy for this probable deficiency is to arrive at an efficient type of grenade which need not be of Arsenal manufacture, but can be turned out in large numbers when required by the Sapper companies and Engineer Field Park. Such a type, however, demands :—

(1). That no materials or explosives should be required in its manufacture which are not already carried by the Companies or the Field Park.

(2). That the design should be of the utmost simplicity, and only require the use of tools already carried by a Sapper Company in the field.

(3). That full working drawings should be readily accessible to all.

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At present there is no such approved design. The official grenade is a costly and complicated machine-made affair of a pattern quite impossible to improvise in the field, and there is no other information on the subject of grenades available to the ordinary man, except such as may have been published from time to time.

To supply this deficiency the three Corps of Sappers and Miners in India (who are faced with the need of a hand grenade more frequently than their confrères at home) have been at the pains of devising various patterns for their own private uses. The following is an account of that adopted by the "Queen Victoria's Own" at Bangalore, and the description and drawings thereof are offered in the hope that they may serve to supply the want referred to above. The grenade in question is the outcome of experiments lasting over nearly a year, and it is claimed that while conditions (1) and (2) have been fulfilled, the grenade is both safe to handle and of extremely destructive effect when fired.

(*a*). *Body.*—The body of the grenade consists of a metal tube $6\frac{11}{16}$ in. long and of $1\frac{5}{16}$ in. internal diameter, or just big enough to admit the ordinary 1 oz. dry guncotton primer. The material of the tube may be block tin sheet, or that obtainable from biscuit, cartridge, or kerosene oil tins, the latter serving the purpose admirably.

(*b*). *Fixed Plug.*—This is a cylindrical plug of wood (*h*) $1\frac{3}{16}$ in. long, and of diameter sufficient to fit the inside of the body tube closely. This is placed within the tube, with its top $1\frac{7}{16}$ in. from one end, and secured in place by two $\frac{3}{4}$-in. screws (*mm*). Through the axis of this plug a hole is previously bored, just large enough to admit and hold a L.M. cartridge ("*x*," *vide* Section C.D.).

(*c*). *Striker Plug.*—Another cylindrical plug of wood (*k*), $1\frac{9}{16}$ in. long and $1\frac{1}{4}$ in. in diameter (*i.e.*, just large enough to slide easily in the body tube) has a nail or screw (*w*) fixed axially in one end, and the head then filed off to a point projecting $\frac{3}{16}$ in. from the wood. This forms the striker (*w*). Now, if the plug (*k*) is dropped into the top of the body tube, the point of the striker (*w*) will rest on the cap of the cartridge (*x*) held in the fixed plug (*h*). The other end of the striker plug (*k*) will still project from the top of the body tube, and a blow on it will explode the cartridge. The point of the striker (*w*) however, is kept $\frac{3}{16}$ in. clear of the cap (*x*) by the striker plug being raised that distance and secured there firstly by the safety pin (*l*), and secondly by the safety wire (*j*). The former, a piece of stiff iron wire, (such as telegraph wire, S.W.G. 12) passes through two

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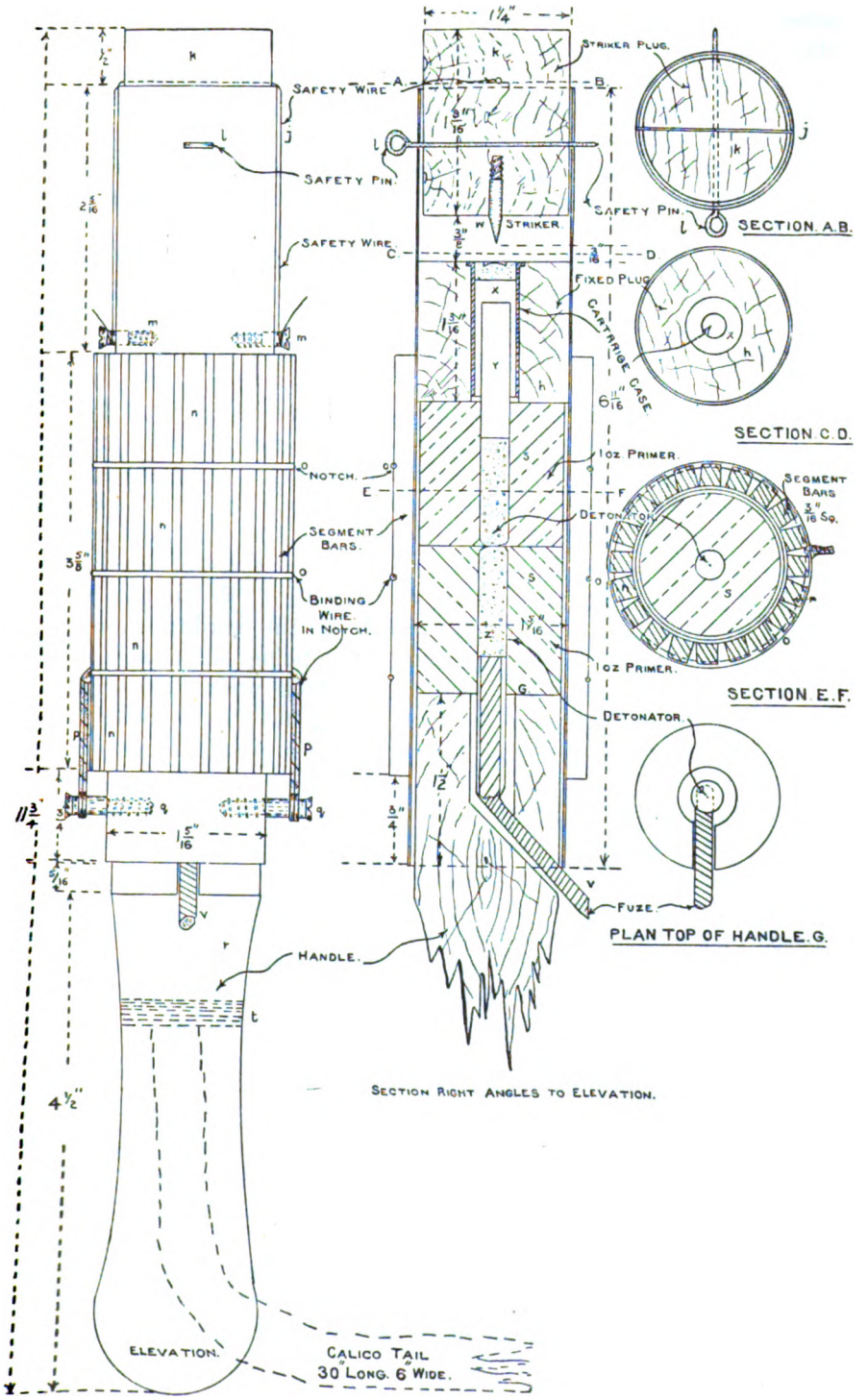

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holes in the opposite sides of the body tube and through the striker plug between them. Accordingly the latter cannot move till the safety pin is withdrawn. The safety wire, which is made of thin copper wire about S.W.G. 20, similarly passes through a second hole in the striker plug, above and at right angles to the first (*vide* Section A.B.), crosses the opposite edges of the top of the body tube, and is finally secured to the two screws (*mm*). A sufficient blow on the top of the striker plug (*k*) after the safety pin (*l*) has been withdrawn, will cause the safety wire (*j*) to shear against the sharp edges of the body tube, allowing the striker (*w*) to impinge on the cartridge cap (*x*). A drop of *two feet* on ordinary hard ground is sufficient to produce this result.

(*d*). *The Explosive Charge.*—At the lower end of the fixed plug (*h*) comes the charge (*ss*), composed of two 1-oz. dry guncotton primers. That nearest the fixed plug (*h*) has a Nobel's Octuple detonator (*y*) fixed in it, the shank projecting upwards into the interior of the L.M. cartridge (*x*) as far as possible. As the cartridge case is unnecessarily long, and would project below the bottom of the fixed plug, it is better to cut it down with a file to the length of the plug, *i.e.*, $1\frac{3}{16}$ in. The whole of the cordite should be withdrawn from the case, the cap alone being sufficient for the action of the grenade. The second guncotton primer (*s*) has likewise an Octuple detonator (*z*) fixed in it, but this is fitted with $3\frac{1}{2}$ in. of safety fuze (*v*) and points in the opposite direction, *i.e.*, downwards.

(*e*). *Handle.*—The still open bottom end of the body tube is now closed, and the whole charge kept snug by a wooden handle (*r*), $6\frac{5}{16}$ in. long over all. This also is made to fit the inside of the body tube closely, and is thrust in from the bottom end until the guncotton charge (*ss*) is held tightly between it and the bottom of the fixed plug (*h*). The handle is then secured in position by the two screws (*qq*). There is a recess in the handle to admit the shank of the lower detonator (*z*), the fuze of which (*v*) is thus led outside the grenade (*vide* Plan G). This handle is used for throwing the grenade.

(*f*). *Tail.*—Secured to the handle (*r*) by a twine whipping (*t*) is a tail of calico 2 ft. 6 in. long and 6 in. wide. This is required to keep the grenade point first during flight, and is crumpled up and held in the right hand, together with the handle, when throwing the grenade.

(*g*). *Projectile.*—To increase the man-killing powers of the grenade, a segment-projectile (*nnnn*) is added. This consists of 20 "segment-bars" (*n*), each $3\frac{1}{2}$ in. long, made of iron rod $\frac{3}{16}$ in. square. To

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assist the bars in breaking up into uniform segments on explosion, each bar is notched in three equidistant places with a cold chisel, thus giving 80 segments each $\frac{7}{8}$ in. × $\frac{3}{16}$ in. × $\frac{3}{16}$ in., and weighing 65·6 grs. These 20 segment-bars are placed so as to surround the centre of the body tube like a faggot, and are secured in place by three belts of wire (*ooo*), each passing round the faggot and screwed up tight with pliers (*vide* Section E.F.). The equidistant notches mentioned above afford good seatings for these belts. To give additional security against shifting, the lowest belt can be joined to the two screws (*qq*) by two short pieces of wire (*pp*), but this is not essential.

(*h*). *Weight and Length.*—The total length of the grenade is 11¾ in. Its weight is 1 lb. 4 ozs. when made from kerosene oil tin; this is composed as follows:—Charge (including detonators, fuze, and cartridge) 3 oz. Projectile 12 oz. Envelope, etc., 5 oz. The action of this grenade is alternative, either percussion or time fuze:—

(*a*). *Percussion.*—The safety pin (*l*) is withdrawn, the *tail crumpled up in the throwing hand*, and the grenade cast overhand in an angle of 30 or 40 degrees, precisely as a stone would be thrown. The tail streams out and ensures the grenade pitching on its head. On impact, the weight of the grenade sets it forward on to the striker plug (*k*). The safety wire (*j*) is cut through by the upper edges of the body tube, and the striker (*w*) impinges on the cartridge cap (*x*). The explosion of this ignites the detonator (*y*), which in turn detonates the guncotton charge (*ss*). If the grenade is not used, the safety pin should be replaced.

(*b*). *Time Fuze.*—All that is necessary in this case is the ignition of the projecting end of the safety fuze (*v*), and the prompt hurling of the grenade. The best method is to hold the grenade in the right hand, ready to throw, and ignite the fuze with the left. Fuze of the length shown will burn for about 7 seconds, which is ample for deliberate lighting and careful throwing of the grenade. The safety pin (*l*) need not be withdrawn, nor need the tail be used, as it is immaterial how the grenade falls. A slightly longer range, in fact, will be obtained by dispensing with the tail altogether.

(i.). *Reasons for Dual Ignition.*—Investigations into previously designed grenades show much diversity of opinion as to which form

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of ignition is preferable. The true solution seems to be to have *both* available if (as in this grenade) it can be done without any special complication of design. Cultivated ground after heavy rain can easily be too soft for a percussion fuze to act with any certainty, unless made so sensitive as to be dangerous to the thrower. Also, in throwing at very short range from the prone position, it is not easy to pitch the grenade up enough to ensure it landing on its head. In such cases the time ignition, whose action is quite certain, can be used instead. Time ignition also enables the grenade to be used for demolition purposes (such as rails) after the removal of the projectile.

(ii.). *Efficiency.*—The weight of charge, and weight and nature of segments given above are the outcome of a large number of experiments. As an example of the action of one of these grenades, the following may be quoted :—The grenade was exploded in the centre of an arena 20 ft. in diameter, whose circumference was formed by a wall of planking 1½ in. thick and 6 ft. high. Forty-three holes were blown clean through the planking by segments. In addition to these there were 140 other hits which did not amount to complete penetration. Of the 63 planks on end which formed the circular enclosure, 12 alone were not touched.

(iii.). *Sensitiveness and Safety of Carriage.*—Experiments have proved that with the safety pin (*l*) in place the grenade cannot be exploded by being thrown or dropped. If necessary, however, still further safety can be ensured by the removal of the cartridge case (*x*) until the grenade is likely to be required. This can be removed or replaced in a few seconds by first removing the striker plug (*k*). The safety pin once withdrawn, the sensitiveness of the percussion arrangement depends chiefly on the thickness and material of the safety wire (*j*). The sensitiveness can therefore be regulated as desired by selection of a suitable gauge of wire. With copper wire of 20 S.W.G., the grenade will explode if dropped 2 ft. on an ordinary road.

(iv.). *Range.*—The grenade can be thrown between 30 and 40 yards by the ordinary unpractised man, and between 40 and 50 by an expert. As some of the segments on bursting go considerably further than this, it follows that the thrower should if possible be behind cover.

(v.). *Time, Labour, Cost and Material.*—Table A is the result of actual experiments at Bangalore. It will be seen from this that the time and labour in the construction of one of these grenades amounts to 4¼ "man-hours." The material required for the construction of any number of grenades can also be ascertained from this Table, always remembering that the various gauges of wire,

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the size of the segment-bars, etc., etc., are by no means unalterable, but merely those which experiment has shown to be the best.

From the same Table the cost is seen to be approximately Rs.1-6-0 per grenade, complete in all respects. This is a satisfactory result, since the price of the grenade mentioned in M.R., Appendix VI., is quoted as £1 14s. 3d. in *The Priced Vocabulary of Stores.*

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TABLE A.—DETAILS OF TIME AND COST OF MANUFACTURE OF 12 HAND GRENADES.

		Hours Work. 1 man 1st rate.	Dimensions L.	B.	T. Inches.	No.	Quantity. lbs.	oz.	Rate. Rs.	A.	P.	Per.	Amount. Rs.	A.	P.
	1. *Carpenters' Work.*														
Labour.	Making Striker plugs, fixed plugs and handles	20	...	...	...	...	...	...	—	4	—	diem.	—	10	—
	Fixing plugs, handles, Safety pin and Wire														
	Attaching tails to handles														
Material.	Deal wood—handles...	..	8	1½	1½	12	...	...	3	0	0	c. ft.	—	6	—
	Teak wood—Fixed and Striker plugs	...	6	1½	1½	12	...	...	3	8	0	c. ft.	—	6	—
	Screws Iron ⅜ in.—Striker and for fixing handles in tubes...	...	—	—	—	36	...	...	—	7	—	Gross.	—	1	9
	,, ½ in.—Fastening fixed plugs in tubes ...	...	—	—	—	24	...	...	—	6	—	Gross.	—	1	—
	Calico, 1 yard wide—Tails	...	72	36	—	1	...	...	—	6	—	Yds.	—	12	—
	String —Attaching Tails to handles... ...	...	12	—	—	12	(inappreciable.)		—	—	—	—	—	1	—
	Wire, Copper, 20 S.W.G.—Safety wires	...	8	—	—	12	(inappreciable.)		—	—	—	—	—	1	—
	2. *Smiths' Work.*														
Labour.	Cutting to size and notching segment bars	10	...	...	...	...	...	...	—	4	—	diem.	—	5	—
	Making Safety pins														
	Cutting Cartridge Cases														
Material.	Iron rod $\frac{3}{16}$ in. by $\frac{3}{16}$ in.—Segment bars		3½	1⅜	⅜	240	9	0	8	8	—	cwt.	—	11	—
	Iron wire 12 S.W.G.—Safety pins		3	—	—	12	(inappreciable.)		—	—	—	—	—	1	—
	3. *Tin Smiths' Work.*														
Labour.	Making body tubes	20	...	...	...	...	...	...	—	4	—	diem.	—	10	—
	Binding on segment bars														
Material.	Kerosene Oil tins—For body tubes		14	9	9	1	...	...	—	3	6	Each.	—	3	6
	Iron Wire, 16 S.W.G.—For binding on bars ...		24	—	—	12	...	4	—	3	6	lb.	—	1	—
	Solder —For Body tubes, etc.		...	...	...	...	...	3	1	3	0	lb.	—	3	9
	4. *Explosives.*														
Labour.	Loading grenades, takes about 5 minutes each	1	...												
	This is done by an officer or other responsible person ...		...												
Material.	G.C. Dry Primers 1 oz.—For charge	...	...	..	...	24	...	...	—	6	—	Each.	9	0	0
	Detonators, Nobel No. 8— ,, ...	...	...	...	...	24	..	...	9	0	6	1000	2	2	8
	Fuze Safety — ,, ...	...	3½	—	—	12	...	..	9	15	0	100 Fms.	0	1	0
	Cartridges, L.M. 303 — ,, ...	...	...	...	...	12	...	...	55	0	0	1000	0	10	7
	Total for 12 Grenades ...	51											16	8	3

Therefore, a single grenade costs approximately Rs. 1-6-0 to make complete with charge, and its Manufacture takes 4¼ man-hours.
If a large number were made at once, both time and cost would be much reduced.

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FORTRESS DEFENCE—CONVENTIONS OPPOSED TO THE OFFENSIVE SPIRIT.

By Major J. W. S. Sewell, R.E.

In a recent R.E. Professional Paper (R.E., IV. 3) Major Matheson traces the evolution of the modern fortress, with especial reference to the growth of the offensive spirit.

A study however, of this paper, and of other recent articles on permanent fortification, leads to the conclusion that in the region of fortress design the offensive spirit is only nascent: it has not yet attained to the stage of maturity which will give it strength to burst the last shackles of convention.

It is proposed in this article to deal with a few remaining conventions of permanent fortification, which appear to be accepted too frequently by engineers as axioms; they are:—the geometrically traced work or "fort," the defensible gorge, the continuous-line idea, as indicated by works between key points, and the retrenchment.

The *Rôle* of Fortresses is to Economize Detachments.

In order to examine the extent to which these ideas impair the offensive spirit, it will be necessary to consider first the *rôle* of fortresses themselves, and then, more fully, the function of a key-point, by whatever name it be called—*point d'appui*, fort, group, or feste.

In the States of Western Europe, with their vast trade based almost entirely on credit, it is hardly conceivable that a war can be carried on for more than a few weeks. Even so, the dislocation of trade must be so great that the loss to the conqueror will only be exceeded by that of the conquered.

Strategy will therefore obviously be directed to fighting a decisive action at the earliest possible moment, and the design and defence of fortresses must conform to such strategy. A defeated state, frequently in the past, has embarked on a *résistance à outrance*, and no doubt will do so in the future, hoping perhaps for a change of fortune, or that internal disorder or foreign intervention will compel the withdrawal of the hostile armies; a vain hope, if history teaches anything. In such resistances, and in certain cases where true strategy has been obscured by political considerations, or by sentiment, stubborn and protracted defences of fortresses have frequently been carried out, honourable indeed to the defenders, but of little eventual avail to the State.

In designing fortresses are we to legislate for such deplorable con-

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ditions? Is it quite clear that the defenders of such fortresses would not have done more damage to the enemy if they had relied less on a passive defence behind trenches, and more on offensive tactics? if they had not yielded all initiative to the enemy, if they had sought to impose their will on him, not merely to place consecutive obstacles in his path?

Too many fortress designs appear to have been prepared as an answer to the query "How can the garrison best be protected?"

The true conundrum for the designer to set before himself is "How can the maximum of damage be inflicted on the enemy?"

In order that the design of the defensive works of a fortress may be treated with due regard to the offensive spirit, it is essential that the designer should divest himself of the idea inculcated in many treatises on fortification, that the *rôle* of a fortress is to cover a locality. For a country that means to win, not merely to resist, the primary *rôle* of a fortress is to cover an offensive movement. As in the case of all defensive works, its function is to economize the defenders' forces and to enable the garrison to "contain" a larger body of the enemy.

Frontier fortresses, for example, behind which the initial concentration of an army is made, enable that army to economize its covering detachments.

Sir G. Clarke points out that the great difficulty in considering permanent fortification is to get away from the conventions of professors, to get soldiers to realize that this subject is not one to be treated as an abstruse science, but is a matter of common sense, and of the fundamental principles of the art of war. The principles which govern the fortification of a defensive position in the field, apply equally to the fortification of a fortress. Thus *Field Service Regulations*, I., 116, says "Since the object of war can only be attained by the destruction of the enemy's field armies, all fortress warfare must be considered as subsidiary to that end." It follows, that the only justification for detaching, to hold a fortress, troops which might otherwise strengthen the field army, can be that those troops should force the enemy to detach troops of greater strength than themselves. Further it follows that if for any reason, such as distance from the immediate theatre of war, a fortress does not compel attention from the enemy, it should ruthlessly be denuded of a garrison.

In order to effect this purpose of "containing" a larger force, the garrison must be prepared to adopt a vigorous offensive. That this fact is not more thoroughly realized—judging from the extravagancies in fortress design which are frequently published—is perhaps due to the extraordinary fascination which has in all ages been exerted by fortresses over hostile armies. For some reason the mere existence of a fortress in a theatre of war appears to have compelled an enemy to detach a large proportion, if not the whole, of his field army, in the endeavour to capture it. Again and again bloody sieges have been

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undertaken, and the main operations delayed for months, in order to effect the capture of a fortress, which, to all appearances might equally well have been "masked." In modern times there may be quoted as cases in point the Siege of Plevna, the total abandonment by the Boers of all active operations in order to prosecute the Sieges of Ladysmith, Kimberley and Mafeking, and in a lesser degree the Siege of Port Arthur. In this last case, it was certainly of vital importance to render the harbour untenable to the Russian fleet, but this could have been, and was eventually accomplished by the capture of 203-Metre Hill, an operation which did not require the 60,000 men of General Nogi's army for six months, nor the loss of many thousand men expended in the capture of the fortress itself. The absence of this army from the main theatre of war might well have decided against the Japanese the hard-fought battle of Liao Yang.

The siege of a fortress moreover appears to dominate the minds of Governments to an extraordinary degree, and causes the principles of strategy to be subordinated to political considerations on the side of the defender as well as of the besieger.

For examples we have the sacrifice of McMahon's army in the mission to relieve Metz, regardless of the German field armies; the concentration of the whole efforts of both sides on the Siege of Sebastapol; and finally the abandonment of all other operations for three months in the attempt to relieve Ladysmith.

On the other hand, the Germans in 1870 proved themselves wonderfully clear headed in this respect, and never allowed themselves to be deflected from, or even delayed in effecting, their main objective, the destruction of the enemy's field army, by the resistance of a fortress.

In considering the defences of a fortress the garrison have no right to assume that an enemy will ignore his true objective, and by attacking the works of the fortress, permit the defenders to impose their will on him. On the contrary, whilst the defenders must be prepared to compel an enemy to submit to all the delays involved in a regular siege, should he design to capture the fortress, they must also be prepared to attack him vigorously should he try, in his turn, to mask the fortress, that is to contain the garrison with inferior forces. The object must in fact be to compel the enemy to detach the maximum possible, and certainly a considerably larger force than is constituted by the garrison, until the decisive battle has been fought. The object of the Engineer must be to produce a fortress which will compel a maximum detachment on the part of the enemy for a given period, not merely a detachment for a period of indefinite duration.

The Offensive is the Soul of the Defence of a Fortress.

We must now consider the means to be adopted to this end. As an example of what to avoid, and the extravagancies into which engineers may be led, when they ignore the spirit of war, we have the fortification designed by a Russian Engineer in the *Injenerni*

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As fundamental principles for fortresses which are to assist in the destruction of the enemy's field armies, we have it laid down (*F.S. Regulations*, I., 128 (1)): "The general principle which governs the defence of fortresses, is that the offensive is the soul of defence," and again (*F.S. Regulations*, I., 128 (4)): "The most effectual means of defence is counter-attack."

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Section 108 (2) lays down that the offensive force should not be much less than half the total.

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In fact a defensive position as conceived in the training manuals of the British Army consists of a strong reserve thoroughly imbued with the spirit of the offensive, and assisted in its attack by the containing action of well-fortified *points d'appui*.

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(1). Counter-approaches (including countermining) designed to outflank the enemy's trenches.
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It is proposed now to examine the methods by which a defensive section "contains" a superior force in field warfare.

Briefly, a defensive section consists of a series of fortified localities or key points, covering the intervals between them with flanking fire, and in themselves capable of great resistance to direct attack (*vide Infantry Training*, 143 (1)). The section has its own mobile reserve, whose duties are not to reinforce threatened works, but are strictly offensive. It is charged with local counter-attack against any hostile force which penetrates the intervals or the key points. As is normally the case with all covering forces, if not itself attacked, it will have to attack, in order to prevent diversion of the hostile troops away to the decisive point. In this attack it will be supported by fire from the key points. All this is clearly laid down in the Official Manuals, and it is precisely the same methods which should be adopted in defending a fortress. In the latter case our works will be improved in details (overhead cover, accessories, and obstacles) within the limits of time and finance, but will be modified in trace merely by considerations connected with the more powerful armament at disposal. In general the effect of this will be to reduce the number of key points, whilst increasing the frontage of each point.

The Evolution of Modern Fortress Design.

Before considering in further detail the design of the key points, a retrospect of the evolution of ideas during the last 50 years may tend to clarify our thoughts.

As the range of weapons increased, it was necessary to obtain greater depth for the distribution of the defenders, and the old key points or bastions were pushed out to a radius which represented a great advance from the old enceinte. But the engineer of those days took out with him his fixed ideas of a conventional trace, and continued to adapt the ground to his conventional bastions; to make matters worse he regarded his new work not as a key point, but as an advanced work, and therefore made it a closed work.

Difficulties immediately arose over the positions for artillery, and the true spirit of offensive war was to a large extent obscured by the controversy which raged over this point. It is clear that guns of position must be covered by a protecting force, itself entrenched. Continental engineers therefore put their guns in the conventionally traced key points, then called forts. The protecting infantry lined the outer lines of these forts as best they could. But the engineers maintained the geometric trace of the obsolete bastion which did not give good resisting power against attack from the front; for it presented salients which were not covered by flanking fire. Moreover,

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Difficulties immediately arose over the positions for artillery, and the true spirit of offensive war was to a large extent obscured by the controversy which raged over this point. It is clear that guns of position must be covered by a protecting force, itself entrenched. Continental engineers therefore put their guns in the conventionally traced key points, then called forts. The protecting infantry lined the outer lines of these forts as best they could. But the engineers maintained the geometric trace of the obsolete bastion which did not give good resisting power against attack from the front; for it presented salients which were not covered by flanking fire. Moreover,

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whilst it was apparently recognized that such a work presented an admirable target to hostile artillery, and the guns themselves were therefore protected by masses of concrete or steel cupolas, the infantry were badly exposed, and all the principles governing the choice of an infantry fire position were vitiated. Thus the trenches were conspicuous, and exposed to enfilade—and in some cases reverse—fire : there was no overhead cover, and little attempt at covered communications : the field of fire was clear certainly, to this extent—that the ground was altered to a true slope, but on the whole, field of fire was sacrificed to a commanding position, with the result that the defenders were much exposed in order to fire down a steep slope : there was usually inadequate provision of cover for supports, and fire control was hardly considered. To adapt such a work to infantry requirements on the outbreak of war involved almost as much labour as a new work would have involved, and then it was a case of making the best of a bad job.

Against these erroneous ideas Sir G. Clarke led the British School who argued that the key point should be a simple type of work for infantry only, and designed with more consideration for the true principles of an infantry work. Guns were to be in the intervals.

Whilst these ideas certainly tended to shake off the vicious shackles of obsolete conventions, they possessed in themselves certain disadvantages which were in opposition to the true offensive spirit. Thus in order to flank intervals with infantry fire alone, it was necessary that the key points should be close together, with intervals of 1,500 to 2,500 yards. This involved the creation of an excessive number of key points. On a radius of 5 miles there would have to be some thirty of these redoubts, which would break the defence into too many sections for the due fostering of the offensive. Moreover the position of the artillery in the intervals was exposed to *coups de main*, and to protect the guns further infantry trenches were to be put in the intervals. The perimeter thus tended to become a continuous line of infantry works, manned at the expense of the reserve, thus sapping the offensive power and spirit of the defenders.

The fortress of this school is thus described by Colonel Jackson, C.M.G., in the *Encyclopædia Britannica*, 11th edition :—"A fully prepared fortress would have practically a complete chain of infantry fighting positions and obstacles between the forts, at all events on the points likely to be seriously attacked." The same author expresses the modern spirit when he says in the same article :—"The teaching of history is all against immobile mechanical defences. Initiative, surprise, unforeseen offensive action . . . all these, with their influence on the *morale* of both sides, tend towards successful defences. . . ."

The great development of the indirect fire of artillery during recent years has assisted greatly in overcoming the apparent difficulties in the way of evolving a fortress key point in consonance with the spirit

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of war: whilst yet further assistance may be obtained from the improvements in quick-firing ordnance. Thus the conception of the modern key point begins to shape itself. In the first place the means to flank the intervals, and for this purpose quick-firing guns appear to be clearly indicated. Secondly the means by which such guns are covered and the key point itself is rendered proof against direct attack, that is to say infantry works adapted to the ground. Thirdly, the economizing of troops by providing that such protection shall also cover the heavy and medium ordnance designed to assist in the destruction of the attackers, and to oppose hostile artillery, which seeks to assist the advance of the attackers. Lastly, the provision of protected communications, stores, magazines and accessories requisite to the mobility, security, and comfort of the defenders.

"Un pionnier" in *Des Forts et la Mélinite* was apparently the first to suggest such a "group" as being the ideal key point: but Sir G. Clarke (*Fortification*, 2nd edition, p. 158) presents the same idea with admirable conciseness:—". . . in the case of an extended line of defence, where the ground offers marked tactical features, the idea of a continuous chain of permanent works may be abandoned in favour of groups of redoubts guarding the artillery positions." The Germans appear to have adopted this conception of a key point in designing the "feste" of Metz.

There is very much danger in attempting to indicate "types" for *points d'appui*. So sure as there are types laid down, so surely will some "professor" allow common sense to be dominated by systems. The designer of a fortress must be thoroughly imbued with the fundamental principles of war, and his aim will be to get the best advantage out of the ground at his disposal. Many of the finest defences of fortresses have been made by defenders who had only earth works to assist them; the reason lying in the fact that those earth works were made by soldiers for soldiers, in accordance with the true principles of defence. Thus the true method is to adapt the trenches to the ground as indicated in the *Manual of Field Engineering*, and then as far as time and money permit to render them more durable, more shell-proof, and more comfortable. In discussing such matters on paper Major Matheson adopts a very sound line, when he chooses a definite piece of ground and shows how he would defend it. It must be regarded as regrettable however that he selected such a site for his work at all. Such a position as the forward slope where he has sited his trenches is one to avoid if it is by any means possible to do so. On such a slope, if the trenches are put at the top, the defenders must be terribly exposed, in order to fire down so steep a slope. If they are placed lower they are badly dominated from the hills opposite, and also lose field of fire. Wherever they are put on this slope, they must be conspicuous, and there is dead ground on the right front at short range.

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It would have been better to have sited the work either further forward beyond the valley, using the latter for lateral communications, or else some 400 or 500 yards back from the crest, whilst covering the valley by artillery fire, either from a flank, if the surrounding country admits of such a course, or with indirect fire if this can be observed. As regards observation of fire, it may be worth noting that whilst air craft may assist artillery by such observation, it is not right to assume, as is often done, that they will be permitted to do so unmolested. Both sides will make use of air craft, the casualties will be very heavy, and as regards a siege, the balance of advantage should lie with the besieger, who is able to bring up fresh supplies of material and pilots.

The inherent errors of the geometric trace are not obviated by siting a conventional fort in the gorge line of the key point as a species of "keep." This is altogether contrary to modern ideas. The *Manual of Field Engineering*, 50 (6), says: "There must be no idea of using trenches arranged in depth as successive lines of defence." Colonel Jackson in his *Encyclopædia Britannica* article is very sweeping: referring to the defence of Arcot by Clive he says:—"Such feats as this make arguments about successive lines of defence and the necessity of keeps seem very barren. History . . . shows no instances where successive lines have been held with such brilliant results." Sir G. Clarke is unsparing in the scathing scorn which he pours upon second lines and keeps. Major Matheson himself says:—"Successive lines of defence lead to false ideas, and almost inevitably to starvation of the main line." He endeavours to forestall criticism by contending that the fort cannot be considered a second line because:—"the position must have depth."

This argument will not hold water; true, a position must have depth, and the supports and reserves must be protected from fire, but the normal action of both supports and reserves takes place in the one (front) line. An argument for a double tier of fire under certain circumstances would be intelligible, but there is no question of that in Major Matheson's design for a *point d'appui* (*Plate* XVIII.).

The argument for a retired defensive line—*i.e.* withdrawn behind the crest line, will appeal to many, especially where the defensive line is of the nature of temporary (*i.e.* field) fortification, and even for permanent works in the very exceptional cases where it is possible to bring effective flanking fire to bear on the slopes in front of the crest: but it is the firing line which must be withdrawn.

A fort as sited in Major Matheson's design cannot come into action until the enemy has captured the front line, except in the case of an assault on the gorge, for which event it is unnecessarily strong. Apparently it is proposed to give the fort a permanent garrison, only 200 men certainly: but these 200 will not be available for action in the decisive place (the front line) at the decisive moment (when it is

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assaulted). In the other alternative of manning the fort with the defeated troops of the front line, it clearly becomes a second line work, and is open to all the objections to a second line.

Summary of Main Factors to be considered.

Now with a view to making a constructive proposal as an alternative, let us enumerate the points to be considered.

(1). A conventional closed fort on the forward slope is objectionable as opening a good target for the enemy's batteries.

(2). It would be seldom possible to site the defensive line on the reverse slope.

(3). Works exposed on the forward slope must be shallow and inconspicuous: whilst sited to obtain a clear field of fire, they must offer a poor target to the enemy's artillery.

(4). A serious obstacle is required in front of the defensive work. All experience points to the value of a deep ditch, well flanked by fire from caponiers.

(5). Accessory works, bombproof as far as possible, are required, such as latrines, cookhouses, look-out posts, C.O.'s post, telephone cabinets, etc.

So far we follow Major Matheson, and we may now add :—

(6). The "returned" flanks of the normal fort are objectionable as they are exposed to enfilading fire. A better flank defence is provided by "refused" trenches, *i.e.* trenches constructed *en échelon*.

(7). Supports and reserves for key points must be provided with bombproof cover, reasonably close to the front line, and with covered approaches giving access to that line. Let us also note that the "feste" reserve will also require bombproof barracks. The *rôle* of the "feste" reserve is similar to that of the fortress reserve, being that of taking offensive action, *i.e.* attacking any hostile troops which may penetrate the "feste."

(8). The forts are the *points d'appui* of the "feste," as the "feste" are themselves the *points d'appui* of the fortress.

As regards (1) the objection lies in the target offered to hostile artillery by the mass of masonry and earthwork enclosed in a compound and well defined by straight lines and angles which constitutes the typical fort of the latter part of the nineteenth century. The solution would appear to lie in a reconsideration of the design of a fort, rather than in siting a fort of obsolete design on the reverse slope.

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The "Conventional" Fort of Geometric Trace *versus* Worksadapted to the Ground.

Now the engineers of all epochs appear to have clung to symmetrical and geometric designs for their work. In the region of field fortifications we are just shaking off the shackles of such erroneous conceptions. It is now recognized that the fundamental principle of field fortification is to suit the work to the ground; thus the first step is to select the best position for each rifle, and the *point d'appui* of a defensive line in the field becomes a chain of rifle pits connected by lateral and radial covered communications, off which open the (covered) accessories.

In the region of permanent fortification the geometric plan is still dominant, the objections being less apparent owing to the fact that defilade enables us to suit the ground to the work to the extent that each rifle has a good field of fire. But not only is defilade a costly process; it also involves angles and hard lines, which render our work the most conspicuous object in the landscape, and as such an excellent artillery target.

Cannot we shake off the shackles of convention and design our works to suit the ground, regardless of geometric symmetry? In this way the fort would follow the lines of a field *point d'appui*, defilade only being used where by such means alone could fire be brought to bear on portions of the foreground; that is to say small inequalities in the foreground—holes and hillocks would be levelled, and the command of the trench would occasionally be raised to obtain fire over a convex slope.

The difference between field and permanent fortification would thus lie only in the improvements possible owing to time being available, that is:—

(1). Better preparation of the foreground, technically "clearing the field of fire."

(2). Improved cover to trenches, communications, and accessories.

(3). More serious obstacles.

Having then selected positions for the rifles in a similar manner to the method adopted in the field, with the assistance gained from such defilade work mentioned above, as will not produce any hard lines or conspicuously "engineered" slope, we shall have a chain of "rifle pits" offering a very small target to hostile artillery, both on account of their shallowness in the line of fire, and of their inconspicuousness. These rifle pits must be provided with splinter-proof overhead cover, say of reinforced concrete, covered with turf; and also with steel loopholes. It is very doubtful whether the very slight risk of a hostile howitzer scoring a direct hit would justify the provision of bombproof overhead cover: it would moreover be very difficult to render inconspicuous such massive cover as would then be required.

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Now as regards cover for lateral and radial communications and accessories; in field fortification we can only provide trenches designed to escape enfilading fire. If time is available and our works become of the semi-permanent type, we should add splinter-proof and weather-proof overhead cover.

In fortress design the conventional fort or redoubt should be abolished and replaced by works whose firing line in general trace is similar to that shown in *Plate* 17, *Manual of Field Engineering*, and with communications and accessories constructed in the manner shown diagrammatically in *Plate* 16 of that manual.

The essential difference between such works and the old fort lies in the fact that whereas the fort consisted of a terreplein surrounded by artificial ramparts raised above the surface, the new work will consist of passages bored in, or dug out of the surface. Such a work has greater resisting power because each rifle is placed in the best position, it is as inconspicuous as it is possible to make a work, as it disturbs the minimum of surface, and it need not be costly. It will however differ from a field work, to the extent that it is found expedient to secure it against the fire of material-destroying artillery—that is heavy high explosive common shells—and this will be decided by considerations of locality, time, and money. A work may be in such a position that it cannot be exposed to any aimed heavy artillery fire; in such a case, splinter-proof protection for the firing line, and weather-proof accessories with a few splinter proofs for supports might be sufficient. This is however improbable in the majority of works. If then it appears *desirable* to render the work proof against all shell fire, considerations of time and money will decide the extent to which it is *possible* to cover in the floor plan with bombproof roofing.

The firing line must have splinter-proof overhead cover in any case. As communications and accessories have been dug out of the ground it will not be an expensive or a laborious matter to roof them in with splinter-proof cover, and it will usually be desirable to do so for the further reason of restoring the natural surface. In some localities this might be sufficient, and the risk might be taken of the occasional common shell which might chance on the invisible roof of a narrow passage.

Proceeding however to the next stage and considering the case of the work which will assuredly have to endure severe bombardment, and supposing that time or money is short, it will be a nice case for the engineer to decide how to make the best of it.

Shall he provide cover all over which will be proof against medium shell, or shall he provide one secure barrack, proof against the heaviest shell, and allow other communications and accessories to have only splinter-proof cover? The former alternative would usually economize more in life, but is risking the moral of the troops if one

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heavy shell does chance to fall on the barrack, and so produce that heavy concentrated loss which is so deleterious to moral.

Certainly the moral of the troops should be the primary consideration, and this indicates the desirability of providing one spot where they can rest in absolute security. Better lose 50 per cent. of life than 100 per cent. of moral.

A matter worthy of investigation arises in the case in which general bombproof cover is considered essential and time and money permit. To provide cover over our communications, etc., proof against the heaviest shells becomes a matter of great expense if it is sought to construct on the "cut-and-cover" principle. Where the firing trench is sited on the forward slope of rising ground, it would certainly appear that the most efficient and even cheapest method of providing such cover would be to mine the communications and accessories in the solid hill. Steps would then descend from each rifle pit to a subterranean lateral gallery, whose ceiling might be from 10 to 20 ft. below the surface according to the resisting qualities of the soil to the penetration of the heaviest siege howitzers.

From this gallery would run radial galleries to bombproof barracks. If the ridge is narrow and the reverse slope sufficiently steep, the rear face of the barracks might open on to a terrace notched out of the reverse slope. But if, as will usually be the case, it is necessary to site the fire trench well down the front slope, or if the hill top be flat or with no pronounced reverse slope, such siting would either place the barracks in an insufficiently secure position, or too far from the firing line. It would then be necessary to construct subterranean barracks, artificially lit and ventilated, and with a gallery continued underground towards the rear, until it is considered expedient to emerge on to the surface.

These barracks would contain sleeping accommodation for the garrison, magazines, stores, administration offices, cookhouse, latrines, telephone room, and engine rooms for provision of artificial light and ventilation, etc.

Other accessories would open off the radial galleries or the main lateral gallery. This gallery would also be continued to communicate with any refused trenches. The platforms for the light guns and machine guns sited in the work, and any search-light emplacements would open off the lateral gallery or radial galleries.

This system of mining out the defensive work, is now 130 years old, having been adopted first by the British Engineers in the defence of Gibraltar in 1779-82, where works on this principle, first suggested by Sergt. Ince, were carried out in the solid limestone rock, and now constitute the world-famous galleries.

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The "Continuous-Line" Convention.

Before considering the intervals it is necessary to reiterate that the objection of the dispersed school to the continental fort containing artillery did not lie so much in the grouping of batteries under cover of infantry works; but rather their arguments were directed against the geometrically traced conventional fort. In seeking to avoid this we have perhaps swung the pendulum too far over in considering the key point as a purely infantry work. This involved covering the intervals with rifle fire; and therefore the key points were to be sited so close together, that we fell into the error of a continuous line of works, instead of designing a few strong key points on which the more passive portion of the defence could concentrate their attention. With few key points however it is essential that the intervals should be flanked by artillery fire. The gun is the true weapon for flank defence, both on account of its moral effect and because it does not involve the exposure of a line of men to enfilade fire, as in the case of a "returned" infantry trench or "flank." If it be conceded that we may rely on the quick-firing gun to flank the intervals and to afford support to the neighbouring key points, it will follow that as the radius of the perimeter of a fortress is increased, the interval between the key points may increase in the same proportion, for they are both decided by the same factor—the range of artillery.

Thus the number of the key points should not be affected by an increase of perimeter. Whilst the tactical features of the ground will decide the sites; so that the precise number of the key points, and the actual intervals will thus be fixed, it may be taken that in a country which is not of a very hilly nature, the number of key points will not vary greatly from 10 to 12, and the intervals will average, very roughly, about half the radius of the girdle of key points. Thus on an 8-mile radius, the average interval would be about 8,000 yards, varying perhaps from 6,000 to 10,000 yards.

Works in Intervals.

As regards the defence of these intervals, it appears to be accepted too much as an axiom that interval works should constitute an integral part of the permanent fortifications of a fortress (compare *The Growth of the Offensive in Fortification*, p. 43, and *Plate* XVIII.). This idea however deserves further consideration. Let us examine the spirit in which the official manuals treat of this point in considering the defensive position in the field. *F.S.R.*, 108 (8), says: "Portions of a position where the conditions are unfavourable to the defence are usually better defended by means of local reserves, than by strengthening the firing line." *Infantry Training*, 143 (1), says: "If these pivot points are naturally strong, or can be made so artificially, and if they are adequately garrisoned, the defence of the intervening ground should not usually be arranged in a continuous line. The

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object should rather be to utilize the intervening ground for local counter-attacks, while arranging for either direct or flanking fire, or both . . . on all ground over which the enemy may advance." *Manual of Field Engineering*, 50 (3): "If the pivots are strongly held and fortified, the troops necessary for the defence of the intervening ground need not be large, and the defence works themselves may be limited to ensuring that the ground invisible to the defenders of the pivot groups is swept by fire."

The fundamental principle underlying these instructions is equally applicable to fortress war. It is—to free every possible man for the offensive force; defensive works and their garrisons being reduced, with this object, to the minimum consistent with safety.

It is obvious of course, that in such intervals as described above, there will be ground which is invisible to the flanking artillery. There may also be important points such as bridges on the lateral communications, which are open to a night assault. It will probably be necessary to cover such ground or points with small closed infantry works. These should however only be of a nature to check an attack until the reserve can come up and drive back the assailants.

It is also obvious that just as there is a proportion between the main intervals and the radius of the perimeter, so there is a proportion between intervals and the distance of the enemy's trenches. Thus, as the hostile trenches on the front of attack approach to rifle range, the intervals must be decreased by interpolating pivots, so that these pivots support each other with rifle fire. But it would appear to be a faulty policy to construct such works before the enemy has shown his hand, for the following reasons:—

(1). On fronts which are not attacked such works are not required: the construction of such works then involves an outlay of expenditure, which would probably have been better expended on the field army.

(2). If such works are constructed and manned, it involves an unnecessary weakening of the offensive force. If they are not manned, they are a source of weakness, inasmuch as it is very difficult to construct a work which, if captured, will not assist the enemy.

(3). The main objection however lies in the fact that construction of such works before the enemy has shown his hand, constitutes an exposure of the cards of the defenders; when the enemy can call them. If on the other hand the defender waits until the enemy has developed his approaches, he can seek to use his trenches offensively by siting them so as to outflank and enfilade the hostile trenches.

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For similar reasons, the intervals are not the places in which obstacles should be placed originally. The chief value of obstacles "lies in the power to deflect the attacking troops into areas most favourable for their destruction by the defenders" (*Manual of Field Engineering*, 42 (1)). At the outset of a siege the object will be to entice the enemy to a premature assault, and to deflect this assault from the key points into the intervals, where the assaulter's troops would find themselves exposed to the enfilading fire of the flanking artillery, and to the full fury of the counter-attack of the reserve, sweeping over ground which is not cut up by trenches and obstacles. Obstacles in Intervals.

We must now turn to the thorny subject of gorge defence. It appears to be an axiom with all engineers that forts and "feste" must be supplied with a defensive gorge. It is somewhat invidious to raise the voice of criticism in the face of so universally accepted an axiom, but it would appear that it is open to argument. In the days of the great engineers of the 16th and 17th centuries, the *points d'appui* or bastions were not closed. It is true that many fortresses have fallen owing to the enemy penetrating a curtain (interval), and capturing the bastion (key point), but it will be found that in such cases either no adequate reserve was held in hand by the fortress commander, or such reserve had no manœuvring space owing to the town extending right up to the ramparts. The Convention of Closed Works.

"Closed" works are proper to certain isolated positions, such as isolated posts and barrier forts; the closure of the *point d'appui* may have arisen from the original method of regarding a fort as an advanced post. The idea that a *point d'appui* in the main line may be captured by assault on the gorge appears to postulate the absence or the passivity of a reserve. In either of these cases the secondary element, that is the *point d'appui*, loses its *raison d'être*. And, on the other hand, a defensive gorge cuts both ways. If it is available to repel an enemy who may assault the gorge, it is of equal avail to an enemy who has captured the fort against a reserve attacking with the object of recapture, (*e.g.* the capture of the Malakoff Redoubt in 1855).

On the other hand, there is the moral effect of the feeling of security engendered by a closed work to be considered. Sir G. Clarke in his *Fortification* says: "The principle of retaining closed works for the infantry redoubts forming the key points . . . has been adhered to mainly on moral grounds." That argument certainly held force where the key points were single infantry redoubts. But where the key points consist of groups, there does not appear to be the same reason for enclosing either the whole group or its constituent elements: open gorges are certainly more consistent with the idea of opposing penetration by counter-attack instead of the step-by-step defence of successive lines.

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Certainly the moral of the troops should be the primary consideration, and this indicates the desirability of providing one spot where they can rest in absolute security. Better lose 50 per cent. of life than 100 per cent. of moral.

A matter worthy of investigation arises in the case in which general bombproof cover is considered essential and time and money permit. To provide cover over our communications, etc., proof against the heaviest shells becomes a matter of great expense if it is sought to construct on the "cut-and-cover" principle. Where the firing trench is sited on the forward slope of rising ground, it would certainly appear that the most efficient and even cheapest method of providing such cover would be to mine the communications and accessories in the solid hill. Steps would then descend from each rifle pit to a subterranean lateral gallery, whose ceiling might be from 10 to 20 ft. below the surface according to the resisting qualities of the soil to the penetration of the heaviest siege howitzers.

From this gallery would run radial galleries to bombproof barracks. If the ridge is narrow and the reverse slope sufficiently steep, the rear face of the barracks might open on to a terrace notched out of the reverse slope. But if, as will usually be the case, it is necessary to site the fire trench well down the front slope, or if the hill top be flat or with no pronounced reverse slope, such siting would either place the barracks in an insufficiently secure position, or too far from the firing line. It would then be necessary to construct subterranean barracks, artificially lit and ventilated, and with a gallery continued underground towards the rear, until it is considered expedient to emerge on to the surface.

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The Convention of Retrenchments.

The same remark applies to the construction of retrenchments, which Major Matheson appears to regard as essential when the attack is being pressed close. The mere fact that a retrenchment is only constructed at so late a stage does not prevent it constituting a second line. Again it may be asked, who is to man the retrenchment? Troops from the reserve? Their proper reply to penetration is vigorous counter-attack before the assailants can form a lodgment.

The defeated troops of the front line? Will they hold a second line after being driven from the first? To reiterate these old arguments against second lines, whether disguised under the name of "fort nucleus," "retrenchment," or any other such appellation, might be regarded as flogging a dead horse, were it not that that hardy but vicious beast periodically shows spasmodic symptoms of a regrettable tenacity to life.

Application of General Principles to Groups of Works.

In designing the groups which constitute the modern key points, these principles are still applicable. Thus the group has its own key points and intervals, and a group reserve, whose function is not to reinforce the firing line but to resist penetration by counter-attack. The "continuous line" idea must still be subordinated to consideration of the strength of the available garrison, and the fire trenches must not be of so extensive a nature as to weaken unduly the force to be kept in hand to constitute the local reserve. But all details will be controlled entirely by the tactical features of the ground. To adapt the works to the ground is the paramount consideration, so as to ensure that all ground within effective rifle range is swept by fire, that the defenders have ample communications, lateral and radial, covered, or at least concealed, and that the key points afford each other mutual support.

Thus the defensive line of the group will consist of two or more infantry works, sweeping the ground to the front with rifle fire, and covering the intervals with either rifle fire from refused trenches, or with machine gun enfilading fire, or most probably with both.

The flanks of the group will be secured by "refused" works, probably of lighter design. The intervals between the key points of this group will be determined by the ground, subject to works being in all cases within effective rifle range of each other. The works themselves will be self-contained as indicated in preceding pages, but it would appear advisable to have open gorges, for reasons given above.

Behind this defensive line will be grouped the siege batteries and their accessories, accommodation for the group reserve of infantry and engineers and the artillery *personnel*, the fighting post and offices of the group commandant, main stores, magazine, etc., etc. As regards all these, engineers agree generally, the main principle being to obtain maximum results for minimum costs. As regards direct fire heavy batteries, rivalry will probably continue to exist

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between advocates of the steel cupola, and of the barbette of reinforced concrete, until the cupola has been tested in an actual siege. But in the design of these batteries and accessories behind the defensive line, there is no mediæval convention to paralyze our minds. When an engineer can start with a clean slate and no type design he can usually be trusted to produce a good design of his own, and that is in general more desirable than losing time in the search for the elusive best design. The curse of the engineer in more fields than one is the convention inherited from his predecessors, which sometimes possesses its own fundamental errors, but far more frequently is applied wrongly, because the engineer of to-day misses the underlying truth, and is bound hand and foot to unessential details, which were never principles, and with the progress of science, have now become not only out of date, but even vicious.

As regards the obstacle, the arguments adduced above against closed gorges, apply equally to an obstacle continued all round a key point (either major or minor). Further the major intervals between the groups, at any rate in the first instance, should be kept clear of obstacles, for the reasons given above. The one certain site for an obstacle is the immediate front of an infantry work. But should this obstacle be continuous along the whole front of the group? The arguments adduced above against obstructing the major intervals do not apply with equal force to the minor intervals, but the principle of the offensive must not be lost sight of. If the frontage of a group be 1,500 yards or more, this is a somewhat long front over which to advertise clearly that we mean to make no offensive move, and to deny ourselves the advantage of surprise. It is not a matter for any dogma, but is again a matter to be decided according to the ground. On the one hand the engineer will place the certain moral advantage of the feeling of security engendered in the garrison of the group by a continuous obstacle between themselves and the enemy. On the other hand he will consider whether by discontinuing the obstacle in a certain interval or intervals, he can increase the offensive power of the group garrison to such an extent as to outweigh this moral advantage. On the one hand, for instance, the presence of a continuous obstacle might permit a trench directly covering a battery to be abolished. On the other hand a very ordinary feature would be a re-entrant valley, inadequately flanked from the pivot works, and therefore tempting to the attacker. But such a feature can be turned into a very death trap to the assailant, and if it is possible to do so, it would be folly to warn the enemy off by closing the mouth of the valley with a continuous obstacle. It is hardly to be supposed that in practice any engineer would make so faulty and vicious a disposition of an obstacle, but the plans published from time to time of theoretical or actual groups of works are so covered with hatching representing a thick con-

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tinuous belt of obstacles (which in fact usually constitutes the most conspicuous feature of the plan) that there is some danger lest such a belt become accepted as another convention.

As regards the nature of the obstacle ; if time and money permit, it is universally agreed that this should take the form of a deep ditch, flanked by counterscarp galleries or caponiers. In this case the objections to straight lines fail, for judicious manipulation of the exterior slope and the glacis can usually be made to conceal the berm of the escarp without involving any hard lines in the slopes themselves. Even if the returned flanks of the ditch become visible to the artillery of the attack, it should not assist that artillery much in hitting the vulnerable trench, whilst a bombardment of the escarp will not very seriously weaken the resisting power of the fort. On the other hand the ditch must be laid out in straight lines in order to render effective the flanking fire from the caponiers. Galleries as in the existing designs would lead from the barracks to the caponiers and also to the magistral gallery whence start the countermine galleries of communication.

In the event of a continuous obstacle being considered desirable, it is obvious that a continuous deep ditch will be financially impossible, and usually tactically undesirable.

With the normal position of the infantry work on a forward slope, it will in most cases be best to "return" flanking ditches to the rear of the crest, and to form the continuous belt from the end of the flank ditch with a wire entanglement in rear of the crest line, provided that in such position it is within the arc of fire of the rifles or machine guns flanking the interval.

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THE WATER SUPPLY OF RISALPUR, N.W.F.P.

By LIEUT. B. T. WILSON, R.E.

As it seems probable that R.E. officers in India may be shortly called upon to design new cantonments and consequently to draw out projects for water supply, practical notes, and plans of a newly installed pumping plant may be of value.

Risalpur was chosen by Lord Kitchener in 1905 as a suitable site for the first cavalry brigade of the then, newly reorganized Indian army. The cantonment, as now built, is situated on virgin sandy soil sloping down to the Kabul River near the old cantonment of Nowshera—the open nature of the surrounding country, which is flat, devoid of cultivation and intersected by deep, dry, ravines makes it especially adapted for the training of cavalry, but at first sight the water supply facilities were not so pleasing to contemplate. In the middle of the cantonment the water was found to contain too much salt to make it suitable for permanent use, but a preliminary well sunk on the banks of a stream called the Kalapani was productive of palatable water. This stream is $1\frac{1}{2}$ miles E. of the cantonment and flows into the Kabul at right angles. This source of supply was approved and the cantonment was put in hand. The original water supply scheme was to pump water from the central well of three wells in the manner shown below :—

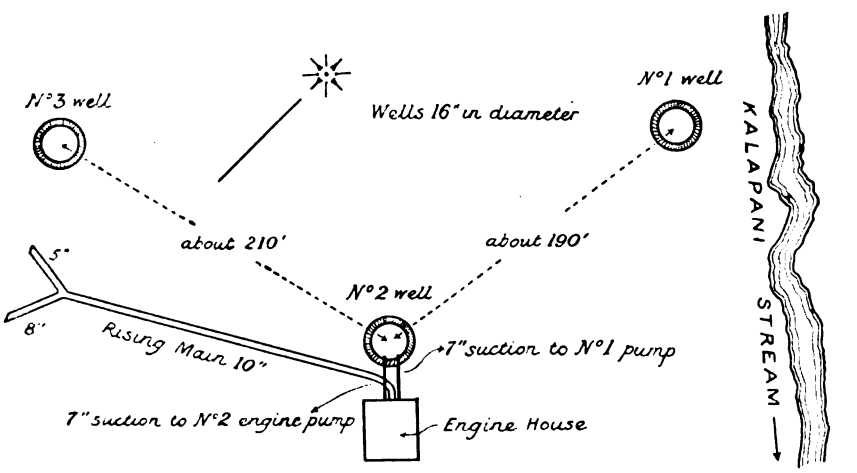

Fig. 1.

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The rising main 10 in. in diameter bifurcated into two branches, the larger (8 in.) going to a raised reservoir of 100,000 gallons, the smaller to an existing earthbank reservoir of 40,000 gallons capacity. The pipe resistances and the gravity heads were so balanced, that water would tend to flow equally to both tanks. The two outer wells were to be connected with the centre well by a 9-in. pipe line laid 14 ft. below the level of the water in the wells before pumping, *i.e.* below the normal water level. The amount of water required was 263,000 gallons and with the pumps working a 16-hour shift, the wells were to be called on for a continuous hourly yield of about 5,500 gallons. This is a brief description of the scheme which the Garrison Engineer was asked to carry out.

As regards the yield from the wells, the experience gained in executing and modifying this project shows that the information contained in the P.W.D. paper No. 63, Simla, 1909, is well borne out in practice. The theory expounded in this paper is that the yield of a well at any one moment depends upon the depth to which the water has been lowered at that moment—in other words the velocity of re-entry of water into a well varies directly as the depth, to which the water level has been reduced or V (velocity in feet per hour) $\propto$ H (head in feet) whence $V=cH$, where c is constant. It is shown that for the sandy soils of the Punjab $C=\frac{1}{2}$ and in so-called "clayey" soils $C=\frac{1}{4}$. By pumping any particular well down to the depth desired, recording the recuperation increments in each quarter of an hour and plotting the results, C can be found by actual experiment (*vide Plate* I.).

The limiting factor in gauging the capacity of a well is the velocity at which water can flow into the well without disturbing the sand of the bottom. If this velocity is exceeded, the capillary tubes, formed by the water entering through the sand, will be broken up and sand will come into the well, thus endangering the stability of the well cylinder foundations. This limiting, or critical velocity, will depend on the kind of sand in the well. In the case of a new well in fine sand, it will naturally be less than with an old well resting in coarse sand or gravel. Experience at Risalpur indicates that even with an entrant velocity of $1\frac{1}{2}$ ft. per hour, sand has infiltrated into the well cylinders. At various places in the Punjab the critical velocity has been as high as $3\frac{1}{2}$ ft. per hour, generally in gravel, and in old wells in which the light sand has in the course of time been all removed. The difficulty then in estimating the yield from a well consists in finding out this critical velocity—in the Punjab it lies between $1\frac{1}{2}$ ft. and $3\frac{1}{2}$ ft. per hour—and the finer the sand of the bottom, the less this velocity will be. To commence with it was thought best to assume this velocity at about 2 ft. per hour, and, taking C at the value determined by tests from $V=cH$, we get the working head of the wells, and the height at which the suction strainers must be fixed.

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Tests taken at Risalpur show that the factor C in the formula $V = cH$ has decreased in value from ·75 in July, 1908, to ·25 in 1912. This is probably either due to a decreased amount of water in the well area, or to the fact that the latter has become choked up owing to its having been overworked before the importance of not exceeding the critical velocity had been fully realized.

In the second case continual cleaning of the well bottoms may be necessary until the fine and choked-up sand has been finally removed. Tests at intervals will show whether any improvement in "c" is being effected. It is, of course often the case that the amount of water in a well area decreases as additional wells are brought into work.

The work of sinking wells Nos. 1, 2 and 3 was accomplished without any special incident and it was only when start was made with sinking the connecting pipes 14 ft. below water level, that difficulty was experienced. Two lengths were actually placed in position at this depth with some difficulty, elaborate shoring and temporary pumping arrangements being necessary. The cost of laying the pipes 14 ft. below water was evidently excessive nor did it appear necessary in view of the fact that the working head of the wells, determined by the method above mentioned, could only be 5 or 6 ft. Besides this difficulty with the connecting pipes, it was evident that the available yield from the wells had been overestimated. Assuming the normal critical velocity of re-entry of the well area to be as high as $2\frac{1}{2}$ ft. per hour, the discharge would only be $2\frac{1}{2} \times \frac{16_1^2}{4}$ c. ft. per hour

$$= 2\tfrac{1}{2} \times \frac{16_1^2}{4} \times 6\tfrac{1}{4} \text{ gallons}$$

$$= 3{,}143 \text{ gallons per hour.}$$

In order to obtain 263,000 gallons in 16 hours and allow one well spare, six wells were evidently necessary instead of the three proposed.

These facts being made clear a revision of the well project was asked for in 1910, and the plans in *Plates* II. and III. were drawn out and approved during the winter of 1910—1911.

In the revised scheme six wells were allowed for, to be connected by horizontal suction pipes above water level to a centrally placed suction chamber from which a suction pipe was to join with pump in use. General arrangements were as below in *Fig.* 2.

To provide for the air collecting in the long suctions, an air pump, run off the main shaft of the engine, will be capable of exhausting the suction chamber. This is made by Evans & Co. of Wolverhampton, who specialize in air pumps of this description.

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The new scheme was carried out in the summer of 1911 and was complete in all main essentials by the winter. No special difficulties were experienced, and only minor alterations to the first draft plans were made.

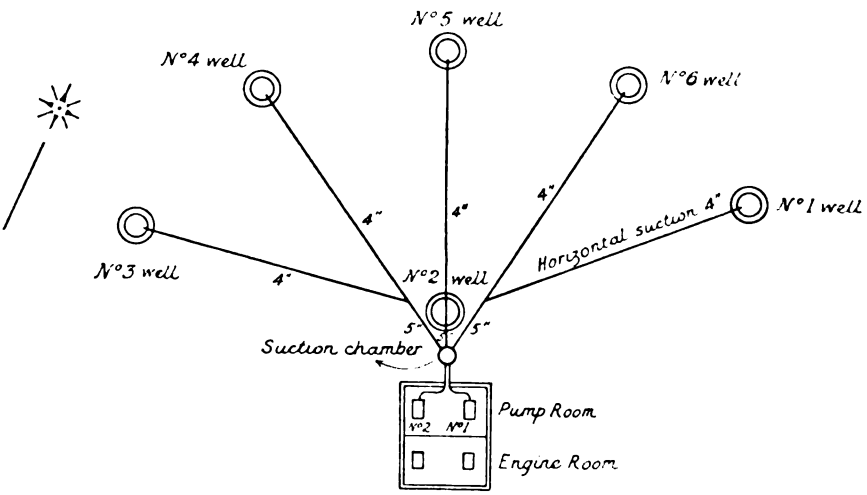

Fig. 2.

The wells were sunk in the manner common to the Punjab. The shaft of the well is excavated at once to water level. The ground usually consists of stiff sandy clay, which will stand up for months in all weathers without any support. Whilst this excavation is in progress the wooden curb of the well cylinder is being made; this is of the roughest description generally of tarash wood with 1-in. bolts and heavy plates. The bolts should project upwards for a distance equal to the amount of water which will be in the well, their ends are fixed into a holdfast ring, fixed in the brickwork of the well steining. The curb complete weighs about 4 tons—a winch, some strong holdfasts and tackle are necessary for lowering it into position. When lowered, it must be accurately centred in the well shaft. This done, 15 or 20 ft. of brick steining are built on the curb and allowed to set for 10 days, after which the actual process of sinking begins. At the start, the water, which has collected overnight is taken out by means of bullocks, and a leather water sack known as a "chursa." Coolies then work about knee deep in water and spade out the sand, the well cylinder sinking gradually as this is done. When the sinking had been done to 15 ft. of water the well is completed by building up the steining, and roofing in. For ordinary irrigation wells the depth of water, which can be obtained

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in this manner is quite sufficient for all purposes. In the case of water supply wells, it is necessary to pump to obtain depths over 10 ft.

Pulsometers were used very successfully in Risalpur for this purpose. It is important to have enough steam power available and to follow exactly the instructions of the maker's pamphlets, which are fully descriptive and quite clear to follow.

The air valves require careful watching—any jarring or irregular action of the ball valve is due to these being out of order.

A by-pass connecting the rising pipe and the suction pipe, as sketched below in *Fig.* 3, enables the discharge of the pulsometer to be regulated to a nicety. Without it the steam has to be constantly turned off owing to the sump hole drying up.

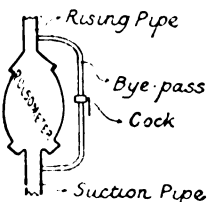

Fig. 3.

In deep wells of 40 ft. to water level and over, or in any special case such as sinking through quick sand, a steel curb is advisable and may be obtained through any of the Indian engineering firms.

These occur at the junctions of the suction pipes of No. 1 and No. 6 wells and of No. 3 and No. 4 wells respectively. Owing to the foundations of these chambers coming where previous excavation had been made in the endeavour to lay the connecting pipes below water level, reinforced concrete slabs were used 4 in. thick, 2 per cent. reinforcement with 12-in. lime concrete over them; they have proved satisfactory. The roofs were the ordinary brick domes well known to Indian bricklayers and mistris.

These call for no special comment. They were built "cut and cover," as earthwork is cheap, owing to Ghilzai labour in the winter.

It will be noted that a 9-in. arch only was used in spite of the heavy filling above (20 ft. average). This latter was put in gradually, and carefully rammed. The ends of the culverts only butted against the wells so as to allow the latter to sink freely, which they do for some time after completion owing to the curbs being founded in sand only. For the same reason the arched openings in the well steinings were cut 1½ ft. higher than the culvert sections.

Owing to the tendency, which the suction pipe strainers have of drawing sand into the wells, it is recommended that they be fixed

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always in the centre of the wells so that as little damage as possible may be done to the well foundations.

The work as a whole formed an interesting study of conditions obtaining in the supply of water from wells. Equally interesting and far more extensive work has been done in this connection at the Punjab stations of Lahore and Amritsar, and no doubt papers are available giving full information of the progress made in these places.

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SCALE OF DEPTHS TO WHICH WATER SURFACE IS LOWERED AT ANY TIME

0	
6"	01 H
1'0"	02 H
1'6"	03 H
2'0"	04 H
2'6"	05 H
3'0"	06 H
3'6"	07 H
3'9"	
4'0"	08 H
4'3"	
4'6"	09 H
4'9"	
5'0"	H
5'3"	
5'6"	
5'7"	

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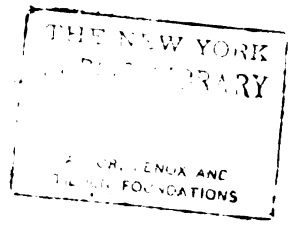

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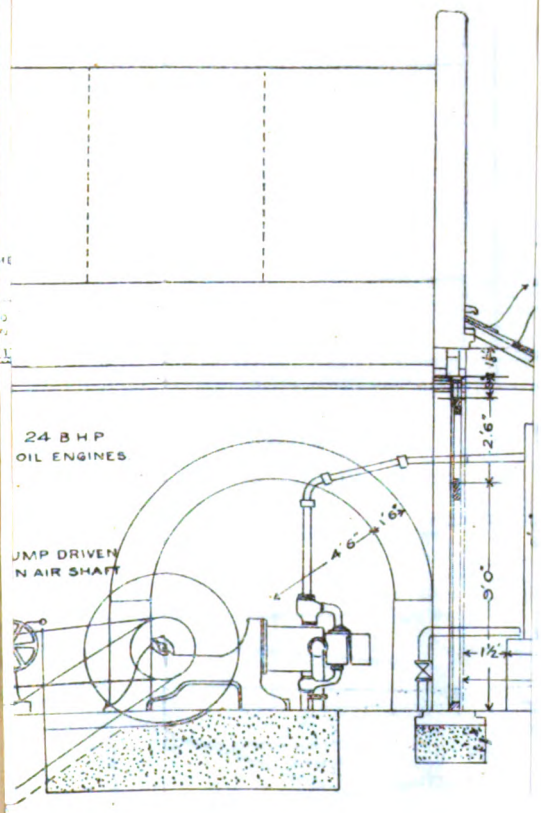

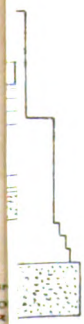

NOTE
RODDI
5' ABO
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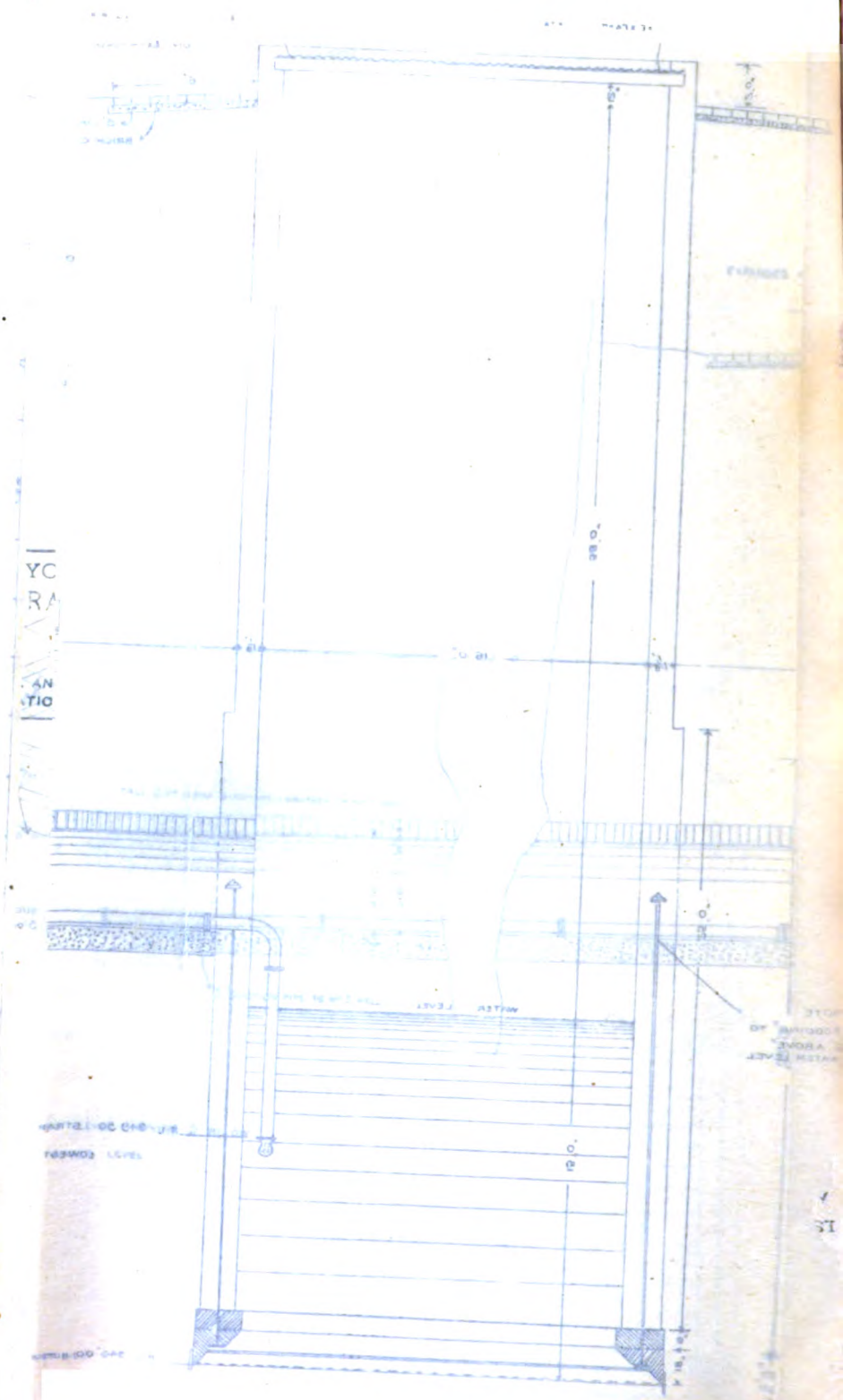

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NOTES ON SERVICE DETECTORS.

By LIEUT. A. H. SCOTT, R.E.

THE object of these notes is to gather into one manuscript divers facts which have been recently published in various technical papers, notably *The Electrician*, on the types of detectors which are actually in use in the Army Signal Service.

These detectors are :—(1), The "Perikon" detector; (2), the "Carborundum" detector; and (3), the "Vacuum Valve" detector. Of these the first is the simplest in action and is the most universally employed.

The "Perikon" Detector (*Fig.* 1).—*Fig.* 1 shows a side elevation of a service pattern "Perikon." The detector is made by arranging a corner of a fragment of zincite to press against a piece of chalcopyrite (iron copper sulphide) or euribisite, and is one of the most sensitive known. It belongs to the class of detectors known as "rectifiers," and can be used with or without the aid of a local voltage.

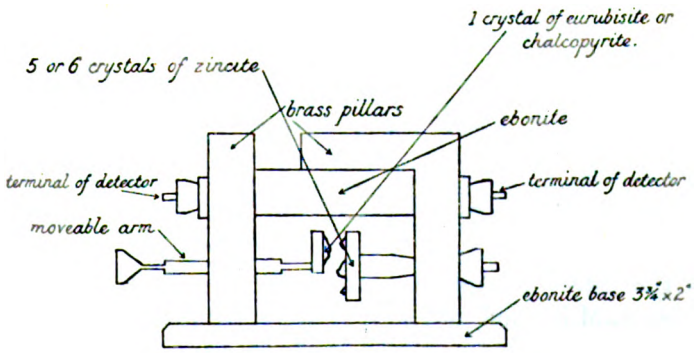

FIG. 1.—*Service Pattern of Perikon Detector.*
(*Side Elevation*).

In the latter case its action is believed to be due to a combination of the Joule and Peltier effects, and can be explained as follows :—"When an alternating voltage, such as is received at the aerial of a radio-telegraphic station, is applied to the detector, the temperature of the junction of crystals rises, owing to (1) the Joulean effect, (2) the Peltier effect. The resistance consequently diminishes and a large current results, which under the influence of the applied voltage

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passes through the junction. When however the voltage is reversed, the resistance of the junction is much increased, since the Peltier effect for a current in the reverse direction is to cool the junction and the greater the current the greater the cooling effect. Thus the amount of current that passes during the second cycle of alternation is very small; *i.e.* the detector acts as a rectifier, permitting only the passage of pulses of uni-directional current. These pulses, if strong enough, are heard in a telephone. In certain cases it is found that a slight difference in potential between the terminals of a detector increases its sensitiveness.

In 1910, Dr. W. H. Eccles carried out some very interesting experiments on the energy relations of certain detectors. His results with regards to the "Perikon" are shown in *Figs.* 2, 3 and 4. *Fig.* 2

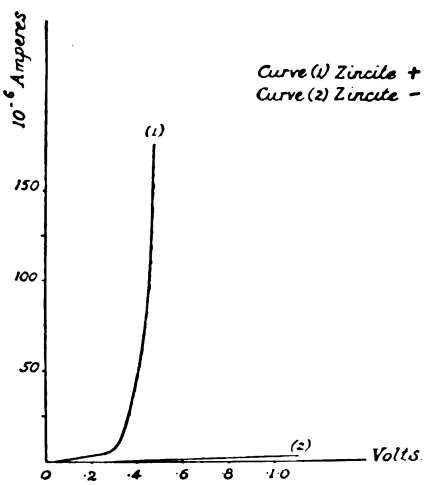

FIG. 2.—*Dr. Eccles' "Steady Current Curves" for the "Zincite Chalcopyrite," i.e. Perikon Detector.*

shows the effect of applying to a Perikon detector a gradually increasing E.M.F., and measuring the corresponding current. The most sensitive condition was discovered to be when the Zincite crystal was maintained at a potential of about ·45 volts below that of the pyrite. *Fig.* 3 shows the relation between the intensity in sound received in the telephone and the energy of trains of oscillations sent through the instrument, the E.M.F. at the terminals of the detector being kept constant. The curves show that even when the detector is used without a local voltage it is very sensitive. To get the maximum effect, however, it is best to have a P.D. of ·45 volts between the terminals, the zincite being the negative terminal. *Fig.* 4 shows the effect of sending trains of constant energy value through the instrument, and measuring the change of intensity in

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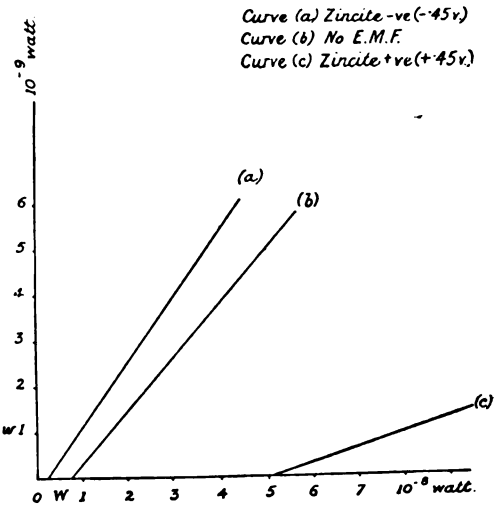
the sound in the telephone, when the steady E.M.F. at the terminals is varied in steps.



w = power delivered by detector to telephone.
W = power given in form of electrical oscillations to detector.

FIG. 3.—*Dr. Eccles' Power Curve for Perikon Detector.*

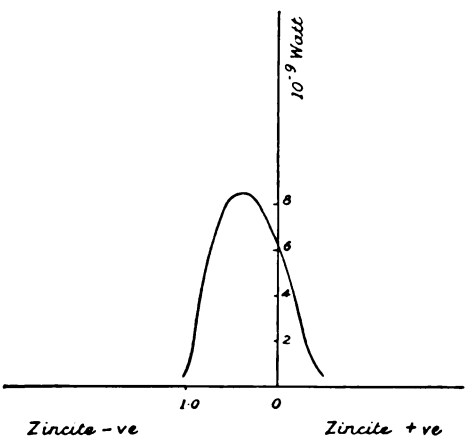


FIG. 4.—*Dr. Eccles' Sensitiveness Curve for Perikon Detector.*

(2). *The "Carborundum" Detector.*—This detector consists of a crystal of carborundum clamped between brass plates so that a smooth crystalline edge, or corner, is in contact with one plate, and a blunt and more amorphous part of the crystal in contact with the other plate.

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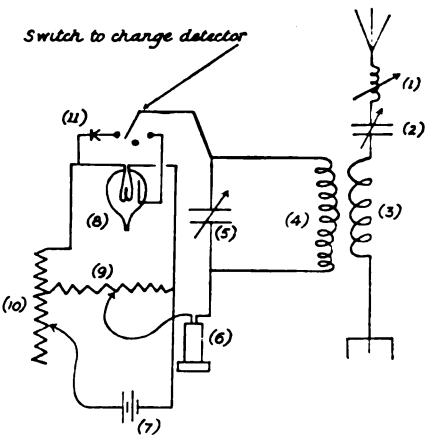
It is similar in action to the Perikon, and *Fig.* 5 shows how it is connected up in certain service sets.



(1) Aerial Tuning Inductance.
(2) ,, ,, Condenser.
(3) Primary of Oscillation Transformer.
(4) Secondary of ,, ,,
(5) Billi Condenser.
(6) Telephone Receiver.
(7) Storage Battery (12 Volts).
(8) Vacuum Valve Detector.
(9) Potentiometer.
(10) Series Resistance.
(11) Carborundum Detector.

FIG. 5.—*Connections with Alternative Carborundum, or Vacuum Valve Detector.*

(3). *The "Valve" Detector.*—The "Vacuum Valve" detector consists of an incandescent lamp of carbon or tungsten, fed by storage batteries, with a small sheet or plate of metal held in the bulb near the filament. The action of this valve is similar to that of the Perikon detector, the alternating voltage received causing a flow of uni-directional impulses from the filament to the plate. These impulses affect a telephone placed in the detector circuit. A potentiometer is provided to obtain the maximum sensitiveness of the valve, and is placed across the battery supplying current to the lamp.

The connections of this detector, which is largely used by Messrs. Marconi in their field sets, are given in *Fig.* 5.

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AUTOMATIC WATER GATES.

By Lieut. J. S. Yule, R.E.

The extraordinary progress that has been made of recent years in the regulation of rivers for purposes of water power and irrigation does not attract, for the most part, wide attention. It is only when the imagination is touched by the completion of a great engineering work, such as the Assouan Dam, and its inauguration by notabilities, or when the lament of a landscape artist at the desecration of Niagara in the interests of electric lighting finds its way into the correspondence columns of the daily press, that the subject is brought before the public eye. Yet the amount of work that is being done in this branch of engineering is tremendous. In Sweden, where water power is available in all the timber-growing districts, the industrial applications have been developed to the full; in other countries of Europe, in America, in New Zealand, progress is equally rapid, and a beginning is now being made in India, Egypt, and Mesopotamia. In all these undertakings it is the organization that is being developed; the general engineering problems are, on the whole, of a type and have perhaps received less attention. A recent attempt to solve one of these problems—the automatic regulation of weirs and flood gates—should be of interest, especially as the solution is on new lines and of singularly attractive ingenuity.

Up to the present no reliable forms of automatic flood gates and sluices have been in use, and it was the obvious necessity for a satisfactory and simple type that led Mr. Henry Davey to pay attention to the problem of their design. It is by his courtesy that I am enabled to describe the result of his work and reproduce his drawings.

The regulation of water for irrigation, or for power, or of rivers against flood must be sure and speedy. In the first case there is ample power available to operate the gates, but in the two other cases, men would probably have to be employed. In all, it is essential to deal with a flood as soon as it begins, and it is only by eliminating as far as possible the human element that this can be done. An automatic flood gate is a power gate and is independent of human control for its action. The general principles of regulation are the same in all cases; but in practice, details and difficulties rise which make for differences. The means of regulation may be divided into three classes, namely:—Weirs, flood gates and sluices.

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WEIRS.

A weir may be used as a dam to raise the level of water in a reservoir, or as a by-pass to prevent the water behind a dam from rising too high. The only automatic one in use is a syphon weir. This is a very simple device, a syphon pipe with the short end cut off and the mouth of the syphon the crest of the weir; but its application is very limited. Any other form of automatic weir must be moving and a moving weir is a flood gate. One form of gate has been devised which is automatic under certain conditions—a rectangular flat gate is pivoted with its axis at the centre of pressure. It is balanced when the head water covers the face, but not against tail water. On the water rising, additional pressure is put over the whole face but as the upper part is twice the area of the lower, the gate tends to open. This gate discharges above and below but it does not hold up the head water. With bottom discharge, the discharge for a given opening of the gate is greater than with a top discharge, and the head water is kept from rising or falling to any great extent.

The two most important conditions that automatic gates should fulfil are :—

(1). That they should be sufficiently sensitive to open at the beginning of a flood when the water has risen only 2 or 3 in.

(2). That, as all gates are subject to variations in conditions of work due to the collection of weeds and grit, the power available for working them must be greatly in excess of that necessary under normal conditions. The power is obtained from the difference in level between the head and tail water and is usually sufficient.

The first of Mr. Davey's gates does not entirely fulfil the first condition. It consists of the shutter described above pivoted at the centre of pressure. The lower portion is covered with a semi-circular shell, to the inside of which the tail water has access (*Fig.* 1). The gate is then balanced for both head and tail water. If this gate in the closed position is at 45 degrees to the horizontal and the top of the hemi-cylinder the normal head water level, when the flood water rises to the top, the tail water will tend to open the gate which is kept down by the water flowing over it. This gate will open and close slowly (as it should do) because the water can only flow slowly in and out of the hemi-cylinder through the hole X. It will be noticed that a considerable rise and fall of flood water is necessary to actuate this weir and it does not therefore fulfil the condition as to sensitiveness. It must be balanced in itself when empty and a weight added to close it again when the flood has ceased.

The next weir is constructed on a somewhat similar principle. It is a hemi-cylinder turning on a hollow trunnion (*Fig.* 2). In a vertical position when the inside of the gate is filled with water the pressure of the head water is on the curved surface and at all points

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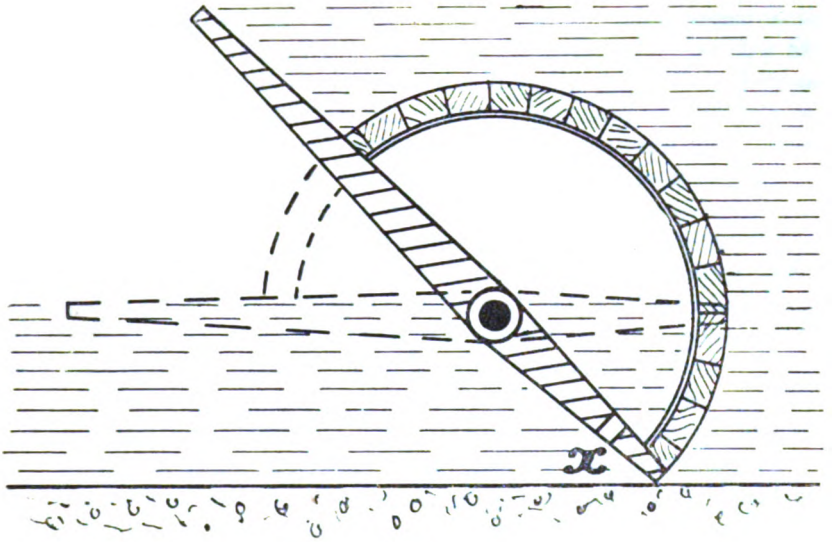

FIG. 1.

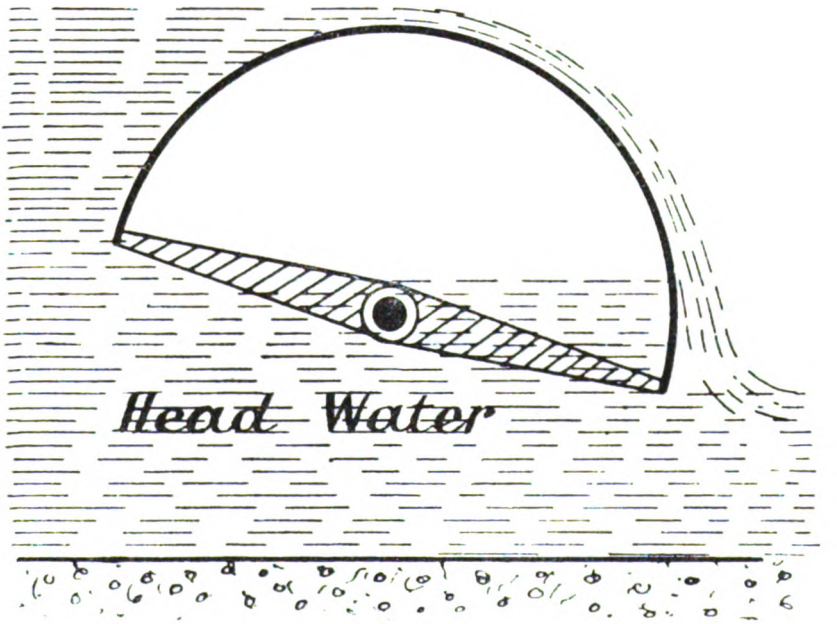

FIG. 2.

normal to it. The resultant pressure passes through the axis of the gate and there is no tendency for the gate to move. It is kept shut by the weight of the shell. When the shell is empty the pressure of the head water is on the vertical surface, and the resultant pressure acting at the centre of pressure two-thirds of the way down, tends to open the weir. If an arrangement can be made by which the gate is

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full of water under normal conditions, and empty in time of flood, the gate will be automatic. This is easily arranged. In a chamber at the end of the gate is placed a float which rises and falls with the rise and fall of the head water. To this float is attached a valve which, when the float falls, admits water through the hollow trunnion to the interior of the shell and closes the gate. When the float falls, the valve closes, the admission of water ceases and at the same time a discharge passage to the tail water opens. This allows the shell to empty and the gate opens. The float and valve are of the simplest nature and can be taken out without disturbing anything else. It is not necessary for the valve (nor the shell, if the valve is sufficiently large) to be water-tight. In fact leakage holes are provided in the lower part of the drum to prevent the accumulation of silt.

It will be seen that as the gate opens, the effective pressure on the gate tending to open it becomes less, because some of it is converted into kinetic energy in giving velocity to the water, and, as the gate tilts, the turning moment decreases. Both causes are compensated for by decrease in the moment of the weight of the gate tending to keep it closed. This gate is very simple. It is very sensitive as it will work with only a rise or fall of 3 in. It is of very strong construction, being in fact a box girder. Lastly, the power available for working it is very greatly in excess of what is necessary under normal conditions. A large hole in the shell would prevent its action, but this contingency could be met by the provision of handgear which would usually be provided for other reasons. The float chamber would be protected by a grating against choking by weeds and other floating obstructions. For short gates this form of weir is expensive but its strength admits of its being made very long; for example, an 8-ft. gate might be 30 ft. long.

The next figure (*Fig.* 3) shows a similar gate operated in such a way that admission and discharge from the interior of the gate is unnecessary. In this case the semi-circular shell is towards the water. At the end of the gate is a square chamber in which fits

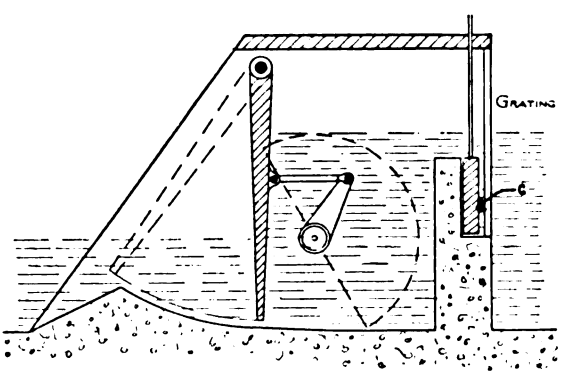

FIG. 3.

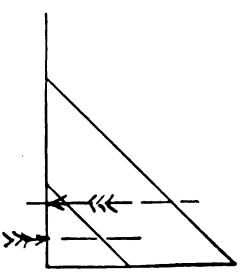

FIG. 3a.

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loosely a radial piston of wood. It is attached to the axle of the gate as shown. The total pressure diagram is *Fig. 3a* in which the small triangle represents the pressures of the tail water and the large one that of the head water with the centre of pressure shown by the arrows. A board *c* protected by a grating may be raised or lowered to fix the head water to any desired level. We can arrange weirs of this kind in sets, two gates 6 ft. by 20 ft. to each actuating piston. What difference of pressure will actuate the gates is a matter for experiment, but if the motion of the piston at the centre of pressure is equal to the circumferential motion of the gate—as it is in the drawings—the moving force, with the piston 6 ft. high and 5 ft. wide, is 3,200 lbs. This is where the tail water is half-way up the gate. If we take a valve as high as ·2 for the co-efficient of friction for the bearings, we only lose 600 lbs., a small fraction of the total available force. With no tail water it is about 4,000 lbs. at the circumference. Leakage can be prevented by the use of semi-circular stanching rods at the ends of the cylinders.

These moving weirs have a distinct advantage over fixed for storage reservoirs, because they hold up the water to the level of the highest flood instead of to the bottom of the spill way, and add this height to the capacity of the reservoir.

Flood Gates.

On rivers, flood gates are very often required to have a far greater discharging capacity than weirs, and have to deal with large obstructions such as trees which are brought down by the floods. The device described above in connection with weirs is employed to actuate falling shutters which cannot be injured by large floating bodies passing over them.

The shutter itself (*Fig.* 4) is hinged at $\frac{2}{3}$rds its depth from the top

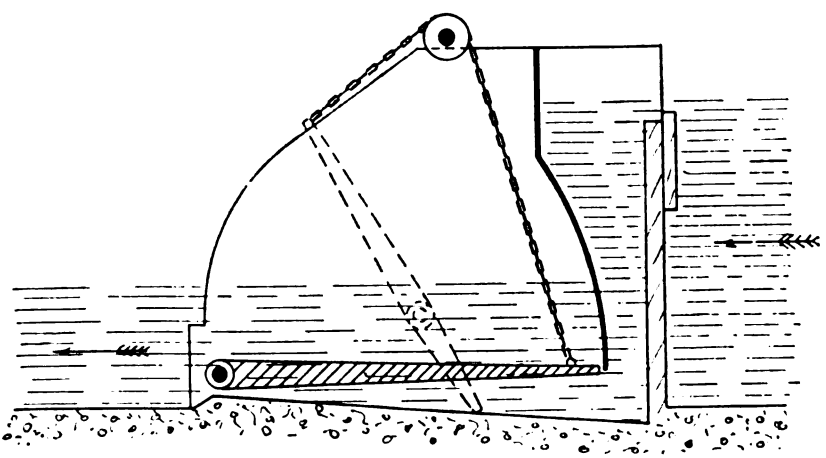

Fig. 4.

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and is actuated by the radial piston device already described. It is balanced on the head water side, but a rise in the tail water tends to open it and this tendency reaches a maximum when the tail water is $\frac{2}{3}$rds the way up the back of the shutter. A ratchet and pawl can be provided to keep the gate down till it is released by hand, which is sometimes desirable.

Collapsible shutters are extensively used in India, but the operation of raising them is always tedious and, in the case of the Ganges canal, the canal head must be closed and the water emptied all but 3 ft. to form a cushion to the falling shutters. A clumsy form of automatic gate is in use on Lake Fifa. The gates are operated by floats working in wells; these are expensive and complicated to construct and their action is uncertain. They take up a great deal of the water way, but gates of the hemi-cylinder type, which can be made longer would not do so to anything like the same extent, and would be better also from the point of view of simplicity and cost.

SLUICES.

The simplest form of automatic sluice is that shown in *Fig.* 5. It is limited in its application but would be useful as a relief sluice on mill dams, etc. The sluice is of triangular section, rising on inclined rails, and is of sufficient weight to resist the pressure of the head water. In an automatic sluice the rise must be less than the rise of flood water, but by ballasting it with water it may be made to rise much higher on letting out the water by hand. The principle involved is made use of in the following designs.

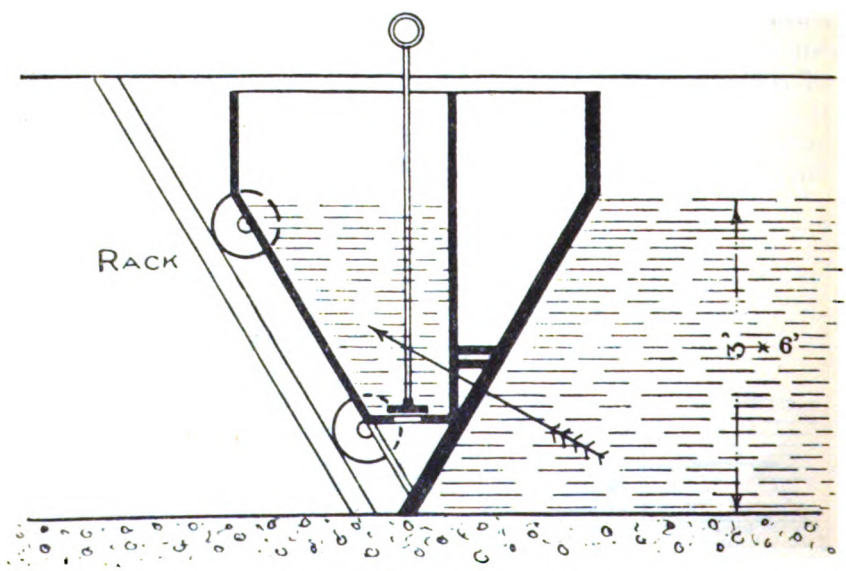

FIG. 5.

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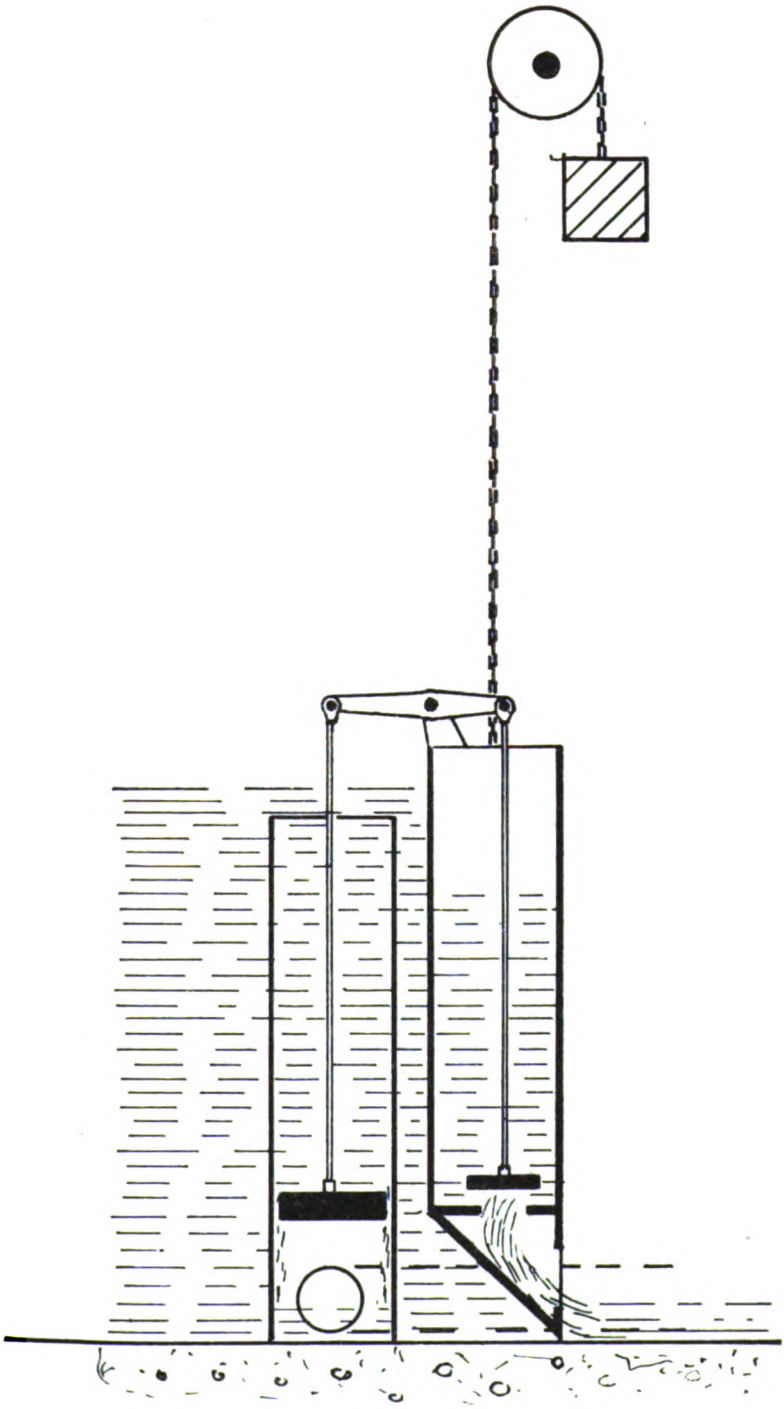

FIG. 6.

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The gate is built hollow and is partly balanced (*Fig.* 6). The unbalanced weight of the gate is sufficient to resist the tendency of the normal head water to lift it. By letting water out of it, it will open, and by filling it again it will close. This is done by means of a valve which is actuated by a rise or fall in the head water. At the end of the gate is a pipe with a loosely fitting piston which is connected to the valve. The bottom of the pipe is open to the tail race. When the head water rises over the top of the pipe the piston is forced down and opens the valve. This lets the water out of the gate which opens. When the head water falls below the level of the top of the pipe and closes the valve, the head water fills the gate through a hole in the face and the gate closes. This gate is supported by the difference in level of the head and tail water.

The gate itself need not be perfectly water-tight ; a considerable leak would be of no consequence provided that a large discharge valve were used. So much of the weight of the gate is balanced that its operation by auxiliary hand power can be easily arranged. The gate runs on wheels fixed in the gate post which only project sufficiently to prevent the sluice touching. If the gate is required water-tight standing rods must be placed in the angle of the gate and post.

All the above designs depend for their action on simple hydraulic principles, and fulfil the requirements for automatic gates which were considered above. They are all simple in construction, and need not be water-tight. In consequence, no elaborate machined parts are necessary. They are sensitive in action and have a big reserve of power for contingencies. The actual movements of the gate themselves are not sudden either in opening or closing so that no harm can be done by unexpected strains coming on the supports due to jerky working. No single design of water gate is universal in application, and it is not claimed that the above short descriptions exhaust the possibilities of the subject. They may, however, be of use to those who have practical experience in these matters, and of interest to others, even though that interest may only be of an academic kind in the neat solution of a problem in hydraulics.

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ECONOMICS OF ENGINEERING.

(*Lecture by* MAJOR W. A. J. O'MEARA, C.M.G., LATE R.E., BARRISTER-AT-LAW, *to Students, Faraday House, 26th February*, 1913).

INTRODUCTION.

THE Science of Economics deals, as you are well aware, broadly speaking with questions which concern the creation, production, distribution, circulation, and conservation of wealth. The expression wealth is naturally not employed here in a restricted sense, as meaning money alone, but is used in a far wider sense, so as to include all those public utilities which are considered practically indispensable by all civilized communities in the age in which we are living. When it is remembered how very large is the part that engineering enterprises, for example, such as canals, harbour works, railways, tramways, etc.,—which are properly said to constitute the wealth of a nation,—have played in recent times and continue to play to-day in contributing to the prosperity of a people, it needs no words of mine to point out the great importance which should be attached to the study of economics in general, and the economics of engineering in particular by all who are now, or may in the future be engaged in the development of our engineering undertakings.

The fundamental principles on which the practice of modern engineering are founded to-day are after all only those upon which the science of economics itself is based. The scientific economist advocates nothing more alarming than the striving after efficiency, in the amplest meaning of this term. And is this not the same lesson which is being inculcated almost daily throughout the year not only by the professors in our engineering schools, but also by the engineers responsible for the welfare of our important engineering undertakings.

It appears to be extremely simple to formulate the conditions necessary to secure the highest degree of efficiency; as a mere statement, nothing more is required to attain this end than to eliminate waste in every shape and form. But when an enquiry is set on foot to ascertain what the application of this simple rule may involve in any particular case, it then soon becomes evident how considerable must be the amount of forethought, preparation, and investigation which must be devoted to the formulation of the exact measures to be adopted in order to realize the results aimed at. In order to obtain the highest degree of efficiency, it is absolutely necessary that all the aids to speculation and enquiry which the wit of man can

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devise should be brought into use. The scientific economist, whatever may be the subject to which his enquiries and investigations may be directed, must resort to experiment, observation, hypothesis, verification, deduction and induction. These are processes which are familiar to you all, and may help you to realize that I am dealing with a subject which is really familiar to you under, perhaps, a different name.

The Science of Engineering Economics, it has been said, is divided into two broad classes, viz. :—The economics of policy and the economics of practice. Unfortunately, in this country it is often assumed that the former concerns the financier exclusively, and is outside the domain of an engineer, although it is freely admitted that the matters comprised in the economics of practice belong more properly to the sphere of the engineer. The views held on this subject in this country by no means coincide with those prevailing in the United States of America, and in many parts of the Continent of Europe. Formerly, when the problems dealt with by the engineer were confined very largely to those relating to the design and construction of structures, and of works of a stationary character such as bridges, roads, aqueducts, etc., it may be, that no very serious disadvantages may have arisen from the separate consideration of these two aspects of the problems connected with the economics of engineering. But to-day the whole character of engineering enterprises is very different from that which prevailed a century, or even less, ago. The engineer is no longer concerned alone, with the design and construction of stationary structures, but also with the development of enterprises which have vastly different characteristics. Many of the problems which the engineer is called on to solve to-day require not only the provision of plant, of which motion is the very essence, but he is also required to prepare projects, which involve from their birth the consideration of the equally, if not more, important questions connected with the methods and means to be adopted to take care of their growth, that is to say, in a double sense engineering enterprises have ceased to be stationary in character. I venture to suggest that even this very cursory glance at the problems associated with modern engineering undertakings is sufficient to indicate that under the altered circumstances of to-day, the solution of the problems connected with the economics of engineering is likely best to be effected by the consideration of the two aspects, those of policy and of practice in combination, and that the education and training of an engineer is as necessary for dealing with the problems connected with the former aspect, as much as these qualifications are essential for dealing with the problems connected with the latter aspect of engineering economics. I recognize that if the only argument which could be advanced in support of the view I have expressed were to consist in a recommendation to follow the

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example of other countries, there would indeed be little to commend in my proposition, and I could not hope to convince. However, as I proceed with my subject, I will endeavour to analyze the situation a little more in detail, and to put before you certain elements involved in the consideration of the problems connected with the economics of engineering as a whole, so that by the time I have reached the concluding part of my paper you may have in your possession sufficient material on which to argue out the situation, and to come to your own conclusions.

I have touched upon this matter here, because after I had accumulated the material for this paper, I experienced some difficulty in separating it, in order that I might deal with it under the two main heads of policy and practice. Finally, I came to the conclusion that it was practically impossible to treat these two aspects of the question as entirely separable and independent.

Engineering covers so wide a field nowadays that, in the time at my disposal, it is quite impossible for me to deal comprehensively with all the matters which affect the economics of engineering. It is, therefore, necessary for me to limit the scope of my subject to such matters as are likely to be of particular interest to my audience. I fancy that the majority of those whom I have the pleasure of addressing here, intend to adopt the career of an electrical engineer, and under these circumstances I feel that I cannot do better than to examine some of the problems connected with the economics of engineering as it affects electrical undertakings. From another point of view this may also prove advantageous, for is it not the enterprises in the field of electrical engineering which are so largely responsible for the difference in the characteristics of the problems dealt with by engineers a century ago, and of those which engage the attention of the majority of engineers to-day to which attention has already been drawn ?

I fully realize that even this limitation may not prove entirely sufficient, for the reason that electrical engineering may be said to represent what at first sight appear to be two opposing interests, namely, that of the manufacturer and that of the consumer. However, so far as the consideration of the subject of economics of engineering is concerned, the problems which require attention have many points of similarity, whether it is the interests of the manufacturer or those of the consumer which have to be investigated. And, indeed, it is possible to go even further than this, for it may be stated as a general proposition, that the interests of the manufacturer of electrical plant are really not opposed to, but coincide with the interests of the consumer, and *vice versâ*. The only real difference in these interests lies in the conception which may be formed of the share of profit which should be derived by the one party or the other in return for the part which he has played in the production of the wealth represented by the success of an undertaking.

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I propose now to deal somewhat more in detail with some of the elements in the situation which affect the economics of engineering. In order to obtain a thoroughly comprehensive grasp of this subject, a fairly wide field of investigation must necessarily be covered as so many collateral matters affect the situation. It is very easy to stray into the fields lying on the borderland of engineering economics, and particularly into that of social economics. It may not be possible for me to avoid a reference to these collateral matters from time to time, but an attempt will be made to confine the paper to those points which more immediately concern the engineer.

An exhaustive investigation into the economics of engineering would require a detailed examination of the subject under several distinct main heads, each requiring further subdivision. I cannot hope, however, to do more than to touch on the fringe of the subject to-day, and will confine my examination to the four main heads, which I hope may prove of most interest and of some value to my audience.

These four main heads are :—

I. Markets ;
II. Methods of management of engineering enterprises and the technical details relating thereto ;
III. Diversity of interests of employers and employed ;
IV. Effects of legislation on engineering enterprises.

I. MARKETS.

The mention of the first of these main heads in a paper dealing with an engineering subject probably brings home to you more clearly than any other statement which I may have made, how great indeed is the difference between the engineering problems of a century ago and those of to-day. Whatever may be the commodity one may have to dispose of, a market containing consumers in sufficient numbers is essential if any progress is to be made. "Seek the consumer," can no longer remain the maxim exclusively of the producer of food supplies, and the purveyor of ordinary household utensils, nor even that of the manufacturing engineers, but it must be, to-day, equally the maxim of all those who undertake to supply consumers with electrical energy on their premises, or who convert it for the purpose of furnishing a public service in one form or another ; thus for example, in the case of both a tramway or a telephone service, consumers must be sought and catered for. But how different are the problems which have to be handled when the products of an electrical engineering undertaking have to be disposed of, as compared with those connected with the search for markets for ordinary wares and the products of the soil ?

In the electrical field, as you are aware, owing to the existence of continuous and alternating current systems of supply, and the various

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voltages which are in use, many technical details have to be considered in the design of electrical plant and accessories, so that it is quite possible that plant, etc., manufactured for one market may be wholly unsuitable for another. These factors naturally affect the question of manufacturing for stock, a matter which is of supreme importance in connection with the economic welfare of a manufacturing concern.

Again, in connection with the supply of electrical energy, technical considerations loom large in the arrangement and character of the distribution system to meet the varying nature of the load which may have to be taken up at different periods during the twenty-four hours. When it is remembered that a very large part of the capital cost of an undertaking for the supply of electrical energy is usually sunk in the distribution network, it can readily be imagined that a faulty disposition of the mains and feeder system may easily affect the economics of such an undertaking from the point of view of earning profits. And if by any chance an unsuitable market has been chosen for the disposal of electrical energy, the situation is by no means so easily dealt with, as is the case where many other kinds of commodities are concerned. It is usually possible to transfer ordinary goods from an unsuitable to a suitable market; true, this involves a loss of payments made for freight, but even so, it may still be possible that under such circumstances no dead loss is incurred; but it is rarely possible to pick up main and distribution conduits and cables in a locality which provides an unprofitable market, in order to relay them in another locality which may provide a remunerative market, without incurring some dead loss.

The question which next requires consideration is whether in electrical engineering matters connected with the choice of, and catering for markets should properly be considered as problems connected with economics of policy, or those connected with the economics of practice. It seems clear from the brief references which have been made on the subject that considerable technical knowledge is really necessary to deal with such questions, and that, indeed, aspects of policy cannot well be efficiently dealt with without at the same time taking into consideration those aspects which affect practice.

II. Methods of Management and Technical Details.

It is proposed now to examine the second of the main heads, which deals with the methods of management of engineering enterprises, and the technical details relating thereto. The matters comprised under this head can be conveniently treated in three main subdivisions :—

(*a*) Organization,
(*b*) Management of the enterprise, and
(*c*) Technical aspects of the enterprise.

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(*a*). *Organization.*

There are certain general principles of organization which are of very general application and require to be strictly observed if efficiency is to be attained, whatever may be the nature of the undertaking or enterprise under consideration. The larger that an organization is, the greater is the benefit to be derived from the application of these principles, which are as follows :—

(i.). The work should be definitely and clearly subdivided, and the control of the different subdivisions should be expressly assigned to specific officers in such a manner that there can be no conflict of authority.

(ii.). A direct chain of command should be constituted, that is to say, every individual in the organization should clearly know to whom and for what work he is responsible.

(iii.). Real authority and responsibility should be created, so that each officer should really supervise the operations for which he is nominally responsible; and the controlling officers should also have direct and individual control of the subordinates employed under them.

(iv.). The choice of officers for the control of the various groups should be determined by the specific nature of their experience and their peculiar aptitude for the duties assigned to them, that is to say, an officer should only supervise work which he is competent to judge and concerning which he can make helpful constructive suggestions to his subordinates.

(v.). The sections into which the work is subdivided for the purposes of supervision should be so arranged as to afford an easy means of ascertaining the costs of each class of work, on a unit basis, at the various stages, so that comparisons of the unit costs at different periods, and, therefore, the efficiency, may be readily determined, and

(vi.). The organization should admit of all routine work being carried out expeditiously and without duplication of process.

The above statements, it is thought, make it quite clear that the staff organization must be adapted to the business or works organization, and not *vice versâ*. This is a matter of considerable importance, and in some countries has received much consideration. It is naturally more difficult to apply the foregoing rules to a particular case, than it is to state them here. The whole object of an efficient organization is to provide co-operation in the highest degree, and to eliminate friction as far as possible, since friction is perhaps the

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most wasteful of all influences in our human institutions. The importance of an efficient organization both with regard to the subdivision of the work and the classification of the Staff cannot be exaggerated, such an organization is, without doubt, the most potent influence in promoting economy. The great point to be borne in mind is, first, to have as few main divisions as possible in your organization, and secondly, to reduce the number of subdivisions in each main division to the lowest limits. A certain number of main divisions are absolutely necessary in every large undertaking in order to provide an efficient control of each specialized branch of work. The character of an undertaking, as a rule, automatically settles the minimum number of such divisions which may be necessary in a particular enterprise. In a large engineering concern, manufacturing plant, which I recently visited, there were but three main divisions, each under the control of an engineer, namely :—

(i.) Engineer's department,
(ii.) The workshops, and
(iii.) Sales department.

This organization may be said to be functional, for the engineer's department is responsible for the design of the plant being manufactured, and the output—including examination and testing on the completion of an order. The manager of the workshop is responsible for producing the articles designed in the engineer's department at the most economical price, and the sales' manager for obtaining orders. The manager of the workshop has his own engineer of methods, whose special duty it is to plan out the various steps necessary to turn out the finished articles required by the engineering department, and at the same time the engineer of methods is at liberty to put up suggestions to his chief for the modification of the details of any design sent into the workshop if thereby economy, without loss of efficiency, is likely to be secured. Suggestions relating to alterations of design must, however, be submitted to the engineer's department for consideration, and approved by it, before adoption in the workshop.

I gathered that this organization works very satisfactorily in practice, and that it is rarely that differences of opinion between the engineer and the manager of the workshop are sufficiently serious to warrant an appeal to the engineer-in-chief and general manager of the undertaking.

Sufficient has been said, it is thought, to demonstrate that in an engineering enterprise matters of organization cannot satisfactorily be considered apart from the technical aspects of the business, and that the details of organization affect problems associated as well with the economics of practice, as those connected with the economics of policy.

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(*b*). *Management.*

It is now necessary to turn to the subject of the Management of Engineering Enterprises. In its general sense, management includes the determination of the policy of a Company or Corporation, as for example such matters as the designing of the organization, the selection of the staff, the acquisition of patents, the supervision of the work done, and the expenditure incurred, the form of the accounts, provision for depreciation, etc. It is on the skill of management that the profits of an undertaking depend.

It is somewhat remarkable that, although commercial institutions have been in existence for some centuries now, and, in consequence, many opportunities have existed to study management as a science, yet as a matter of fact exceedingly small progress has been made in studying the important problems connected with this subject. Indeed, it is admitted that modern industries have developed far more rapidly from the technical point of view than they have either in respect of the organization of the services, or in the management of modern businesses. So thoroughly is this realized in some countries, that a movement is on foot to obtain official recognition for a diploma course in commercial engineering in order to train men to deal with problems of management. Many of the questions which affect the management of an engineering enterprise require for their solution minute calculations that can only be made by trained experts, and these can only be made on the basis of exact and carefully sifted statistical data: to take but one example, that of the value of a patent, who but a technical expert can really determine the financial value of a patent process or device to a given undertaking?

Policy questions in engineering, it is clear, resolve themselves into the consideration of the costs of alternative schemes, of which the various elements have been carefully considered and brought to account; and generally speaking it is dangerous from the point of view of the economics of engineering, to ignore the answer which is provided by the figures of annual cost in such cases. Competition is essential, and in the case of engineering enterprises the taking of risks must depend also on the study of the technical aspects of the question. Therefore, so far as our subject is concerned it would again appear that the economics of policy and the economics of practice cannot without some disadvantage be considered separately.

(*c*). *Technical Aspects.*

The next subdivision deals with the technical aspects of the enterprise, and involves mainly questions of practice which are extremely familiar to you, and I therefore propose to review them very briefly indeed, although even in the field of electrical engineering alone they cover a wide ground.

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Now that engineering problems are becoming more and more complex, the mastery which an engineer must necessarily acquire in his every-day work of the matters comprised under this head, must tend, it seems to me, gradually to enhance his value in the industrial world.

The matters comprised in this branch of the subject may be conveniently considered under six heads :—

(i.). Materials.
(ii.). Design.
(iii.). Lay out.
(iv.). Methods of execution.
(v.). Operating of plant.
(vi.). Accounting.

(i.). *Economy of Materials.*—The importance of exact knowledge concerning the properties of the materials used by engineers has fortunately been long recognized, and, in consequence, much valuable data has been accumulated concerning their physical properties, and the efficacy of the various preservatives employed to prolong their life. You are all fully aware that the engineer who possesses knowledge of the physical properties of materials, the forms in which they can be purchased on the market, the useful life of various kinds of materials, the price at which the materials required can be purchased at the date of demand, and the different conditions under which they may be employed in structures and machines, is readily able to determine whether the employment of one material or another will prove most economical in any particular case, and I need not therefore enter into any further details on this head here.

(ii.). *Economy of Design.*—Matters connected with design give free play to the imagination, or in other words, the inventive genius of the engineer; and he who has best mastered the leading principles in the sciences which are included under the subject of Physics, and is able to apply these principles in some one or more original combinations, is on the high road to success. It is well to remember that an idea is often the source of great wealth, and it is new ideas which promote the economics of engineering, and bring about that progress which is continually going forward. The more complete your knowledge of the sciences associated with the art of the engineer, the more will it lay in your power to do your share in promoting the economics of engineering. This knowledge combined with that concerning the properties of materials will prove invaluable to you, particularly at times when there may be an enhancement in the price of certain materials either owing to their scarcity, or to the effects of legislation; for it will be possible for you readily to think of substitutes which will under the circumstances

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serve your purpose in the place of materials which are either unprocurable, or too costly for the purpose you have in view.

(iii.). *Economics of Lay-Out.*—Under this head fall questions relating to the location of generating stations, sub-stations, the routes of main and distributing conductors, the routes of tramways and sizes of the cars, the planning of a factory, the types of machines to be installed, provision to be made for the storage, etc., of new material, arrangements to be made for the disposal of the finished articles, etc. In many of these cases, questions have to be considered relating to future extensions, and also those relating to the steps to be taken to restore the services in case of a temporary breakdown. The character of modern engineering undertakings is so various that the problems connected with the lay-out in different kinds of undertakings naturally vary considerably, and are innumerable. It would not be profitable for me to do more than mention the subject as one having a considerable influence on the economics of engineering. So much has been written on this head in relation to practically every branch of electrical engineering that no difficulty need be experienced in obtaining very exact data for dealing with each class of problem which may present itself to the practising engineer, not only from text-books, but often better still from the pages of the *Journal of the Institution of Electrical Engineers.*

The problems connected with this branch of the economics of engineering involve the study of the methods to be adopted in order that the investment of capital necessary for the attainment of definite results may be reduced to a minimum. The investigation of this aspect of the question is closely associated with that of design, and you are all familiar with the many devices resorted to by engineers to maintain the enterprises in their care at the smallest annual expenditure, such for instance, as apparatus for improving the power factor of alternating current systems, the employment of accumulators in connection with central station supply, boosters, etc. I can only add that, in order to be quite up to date in these matters, it is essential that the engineer should consult the most recent issues of the *Journal of the Institution of Electrical Engineers.*

(iv.). *Economy in Methods of Execution.*—Works may be either executed by the workmen employed directly by an undertaker, or by contract. So far as the undertaker is concerned, the results obtained may prove different, but from the point of view of the economics of engineering, the principles involved are identical.

The most sure method of ensuring economy in execution consists in the careful preparation of the programme dealing with the order and the method in which the details of a work are to be carried out, and in the adoption of an organization, in the case of the gangs of workmen, suitable for this purpose. A matter which often requires

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considerable attention in the execution of new works is that connected with the delivery of machinery and materials on the site of the work at the due date. Failure in this respect throws the gangs out of work and often involves a considerable waste of money, and has been at times the only reason which has caused a contract to prove unprofitable. Such failures can generally be obviated by careful supervision, and the preparation and submission of requisitions for materials in good time. It need hardly be pointed out here that it is the efficiency of supervision which more than anything else promotes economy during the execution of a work. Another question which also has considerable influence on the economics of engineering is that connected with the distribution of work in such a manner that the skilled hands shall be kept employed at their trades all the year round. Dismissal of such men may, at times, result in their drifting into other occupations, and, therefore, getting out of the reach of an employer when most wanted. It may not always be possible to prevent the dismissal of skilled hands, but forethought and skilful management can often reduce the necessity for the adoption of such a course to a minimum.

(v.). *Economics of Operating of Plant.*—The character of the plants to be operated, and the nature of the enterprises in which the same kinds of plant are to be found differ so widely that here again it is only possible in the limited time which is available to attempt a very general survey of this aspect of the question. The problems which fall into this group are those which relate to the steps to be taken in order to avoid waste of fuel and stores, to utilize to the best advantage the services of individual members of the staff and individual machines, to reduce to a minimum the idle time of the men and of machines, etc.

Considerable progress has already been made in coping with the questions which fall under this head, particularly by the introduction of automatic appliances which, fortunately, have reduced the waste of fuel and other materials, as well as having contributed largely to a reduction in labour charges. However, in many engineering enterprises the control of labour expenses is still a matter of considerable difficulty, and this is particularly so in those undertakings in which the plant consists of a network spread out over a comparatively large extent of territory, as for example, in the case of electric power supply and of telegraph and telephone undertakings. In such cases the outdoor staff is continually on the move, making supervision and control difficult, if not impossible. The most effective means of ensuring economy in such cases consists in the systematisation of the various kinds of operations, and the assignment of factorial values (in hours) to the different items of work. The check then becomes a statistical one. It is sometimes possible to utilize these factorial values for delimiting the area within which each individual workman

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should be employed, and in such cases they act to some extent as an anticipatory check before expense is actually incurred. In cases where direct supervision is practically impossible, I have found this method invaluable.

Another method which is largely employed to control the work of even individual workmen is that involving the issue of a "Works Order" for every separate job. The "Works Orders" naturally provide the means of calculating the unit cost of the various classes of work, and thus information can always be obtained for comparing the relative values of the men employed on similar classes of work.

There are some situations where the volume of work varies in an extremely regular manner from hour to hour throughout the day: this is the case in the manipulation branches of the telegraph and telephone services. In such cases, it is usual to plot the load, hour by hour, as a curve, and to plot a second curve showing the numbers of operators required to deal with the loads shown in the first curve during each of the hours of the day. The duty rosters can then be easily compiled from the information derived from the second curve. There may be other situations also in which this method of control may prove valuable. This is also a check of the anticipatory type, which after all is the best in those cases in which you have the necessary data to apply it. The value of a proper system of statistics as an aid in controlling the operations of a large undertaking cannot be exaggerated. It is really astonishing how readily statistics prepared on a sound basis indicate sources of waste, and, in consequence, serve the purpose of those who are interested in the economics of an undertaking.

(vi.). *Accounting.*—The antiquity of accounting, in some measure, indicates its importance. The earliest system in Great Britain dates back to the beginning of the twelfth century. The oldest statement of account in this country now in existence is the English Pipe Roll for the year 1130—1131; and the oldest private account in existence is the Household Roll of Eleanor, Countess of Leicester, for 1265. Questions relating to accounting affect both the economics of policy and the economics of practice. The cost at which a commodity can be supplied, whether in the form of electrical energy or of a machine, must vary according to :—

(*a*). The value of all the plant employed in producing the commodity in question, which is composed of three elements, namely :—

(i.). Interest on capital.
(ii.). Annual depreciation charges.
(iii.). Annual expenditure for minor repairs.

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(*b*). The period during which the plant is in use in producing the commodity, in which is included the time during which the plant is idle.

(*c*). The cost of labour required to operate the plant, which includes the value of the time lost, and also supervision and management charges.

It is essential for the successful operation of an undertaking that capital charges shall be kept down; it is therefore permissible to charge the cost of new works to the revenue account, but the charging of maintenance costs against the capital account will always invite the criticism of an auditor. And you will readily recognize that this should be so. There are various methods in which the charge for depreciation may be brought to account; a comparative examination of these methods form a subject for special enquiry, which is outside the scope of this paper. The questions relating to the capital account and depreciation are matters which to a great extent belong to the province of policy; whilst questions affecting running costs, that is to say expenditure on minor repairs, cost of labour, of supervision, and of management are matters which belong more properly to the province of practice.

Matters relating to the capital account and depreciation need not, it is thought, be further pursued here; but those relating to running costs are of such immediate importance to the engineer that a few words will not perhaps be out of place here.

Much study has been given in recent years to scientific cost finding, and, as enterprises become more complex, the methods of accounting for ascertaining running costs become increasingly important. However much care may be devoted to the elimination of waste in the several operations which have already been referred to, yet no advantage will be derived therefrom, unless at the same time the system of accounting adopted can show at what cost definite savings in actual expenditure have been obtained. No single model of accounting is likely to combine all those features which will render it universally suitable, without modification, to meet the requirements of every kind of enterprise. In any particular case the best results are likely to be obtained by the joint study of the special features of the undertaking in question by expert accountants and engineers. The preparation of an accounting system which is based on such a study will be of most value to the latter in effecting his control, whilst at the same time providing a means for ascertaining the components in the cost of the various important items required by the management for fixing sale prices of the commodities produced by the undertaking. How very important the subject of scientific cost finding really is, may be gathered from the announcements in *The Times* of the 19th and 20th February last, which state that recently the printing

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trade has been affected by the changing conditions of the times. The reduced working hours in London, charges under the Insurance Act, the increase in the cost of materials have been factors which have raised the cost of production. In consequence, the Master Printers appointed a committee to investigate the question and to put forward proposals. This committee has completed its task and by taking the best features of the systems investigated by it, it has produced a system adapted to printing businesses from 2 to 30 departments, and consisting of from 10 to 1,000 employés. In these days of keen competition exact knowledge as to the cost of production of the commodities which an undertaking desires to place on the market is absolutely essential; it is for this reason that a scientific system of cost accounts is necessary in every engineering undertaking in which regard is paid to the economics of the enterprise.

III. Diversity of Interests of Employers and Employed.

The interests of employers and employed are identical so far as the production of wealth is considered, but when it comes to a question of distribution there is a real divergence. It is this divergence which has led in modern times to the serious and almost continuous conflicts between capital and labour. It is difficult to estimate the enormous loss of wealth which has been involved in this struggle. Naturally economists have endeavoured to devise measures to remove, as far as may be possible, the causes tending to produce these disastrous conflicts. Profit sharing and co-operative production have been tried as remedies: the former appears to secure the greater advantages with lesser disadvantages. Profit sharing elicits the interests of the workman in the enterprise, while at the same time permitting the control and management to remain vested in the hands of the employers, whose skill and experience are essential to the success of important industrial undertakings, and it is in this latter respect that profit sharing differs from co-operative production.

Another remedy which has been tried is that of Conciliation Boards. Such institutions have existed in our Colonies and in some European States for some years past, and as you are probably aware such Conciliation Boards were brought into existence in this country very recently in connection with the Great Railway Strike about two years ago. Perhaps the best known example of Conciliation Boards are the *Conseils de prud hommes* in France and Belgium, whose functions are not concerned with the determination of the general rate of wages for the future, but with the interpretation of particular contracts. These *Conseils* are also occupied with the redress of minor grievances and the adjustment of individual quarrels.

Since every measure which tends to bring about harmony between the conflicting interests of capital and labour, directly and indirectly,

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is a means of reducing waste of wealth, the study of the weak and strong points of the various remedies suggested, and adopted, is of value in connection with the consideration of problems connected with the economics of engineering. The subject is a wide one and perhaps strictly speaking forms part of the subject of social economics. It is thought that this passing reference is sufficient to bring the matter to your attention.

IV. Effects of Legislation on Engineering Enterprise.

Legislation has in recent years materially affected the problems connected with the economics of engineering, as indeed the economics relating to all industries. The enactments of the legislature which have found their way on to the Statute Rolls have not only altered the conditions existing in our factories, but also the relations existing between employers and employed. The tendency of such legislation has been to put an increasing burden and responsibility on the shoulders of those associated with the control and management of engineering enterprises. The field covered by this legislation is so wide that I must content myself with merely drawing your attention to the fact that in dealing with problems of economics of engineering it is necessary to bear in mind that existing statutes, and, in some cases, even those which may be under the consideration of the legislature, introduce factors into the situation which cannot with prudence be overlooked by you.

Conclusion.

I fear that I have only been able to put before you a bare outline of the nature of the problems connected with the economics of engineering, however, I hope I have put sufficient material before you to enable you to realize to what extent the policy aspect is associated with that of practice in that branch of engineering with which you propose to concern yourselves. I can only hope that the day is not far distant when the engineer will occupy a recognized status and controlling influence in the engineering industries of this country. The progress made in this direction will largely depend on your own efforts; the future of a great profession lies in your hands. It is by a study of all the matters I have outlined that you will put yourself in the most advantageous position to discharge your duties so as to bring added prestige to your profession. You cannot have failed to realize fully that, under the conditions of to-day, in the higher lines of engineering work the difference between mediocre qualifications and high grade knowledge will often mean the saving of thousands of pounds to a community whose interests are entrusted to an engineer.

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That you all desire to be ranked in due course with the high grade men of your time goes without saying, and there is no doubt in my mind whatever, that there is no surer way to your attaining the height of your ambition than that of assuming the *rôle* of an economist, whose mission, as has been shown, it is to discern and to assist others to recognize the unseen waste which is continuously going on. I can only trust that the remarks which I have made to-day, may have indicated with sufficient precision the means by which you may obtain personal success, and, by which, at the same time, you may be able do your share in raising the calling of an engineer to the foremost rank among the learned professions.

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NOTICES OF MAGAZINES.

Militär Wochenblatt.

German Airships at the Commencement of 1913.

The following is a *résumé* of an article by Capt. Romberg, with the above title :—

The past year has proved in a high degree the reliability of the German airships. It now remains to make a practical use of the experiences that have been gained and to maintain Germany's superiority in airships. Although they have lately shown their independence of wind, which was quite unhoped for, their use is still restricted by weather influences. The power of these influences can in some measure be diminished by the construction of suitable hangars ; for most of the airship accidents have occurred in getting the craft in and out of their sheds. "Double hangars" have been built so that the airship can be got out obliquely, and screens to which they can be made fast running on rails have been tried to provide shelter from the wind. But there are not enough and the writer advocates "triple hangars" and looks forward to "revolving hangars" coming into universal use. One of these has been built by Siemens Schuckert, and is now in possession of the army. The revolving hangar is kept with its axis in the direction of the wind, the entrance to leeward. This orientation of the hangar assists landing, as it indicates to the pilot the direction of the wind at ground level. Efforts must be made to reduce the cost of production of hydrogen and to get a motor spirit that can be made from native German products. Capt. Romberg considers that air craft could usefully be employed on postal service and for survey work.

The day of small airships is over, their place is taken by aeroplanes. The size must depend on the speed, radius of action and carrying capacity required, and they cannot be too great. A ship must have at least two motors; some of the big ships have three and four. Most of the Zeppelin and Parseval ships use the Maybach motor.

As regards radius of action, field hangars are out of the question, and airships must start from and return to their own permanent ones.

In construction, the liability to damage on landing must be borne in mind. The non-rigid types have advantages in this respect, but by use of wood in the body of the airship the necessary elasticity and strength can be obtained, as has been shown in the Schütte-Lanz airship. The Siemens-Schuckert airship has achieved a speed of 20 metres per second (about 45 miles an hour). This can no doubt be improved on. The Zeppelin airships, with the one exception of the "Schwaber,"

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which travelled 17,076 miles before it was burnt on 28th July, 1912, have shown themselves wonderfully reliable. The "Victoria Luisa" travelled roughly 18,000 miles between February and November, 1912, and the "Hansa," 7,300 miles between July and November. Eighteen Parsevals are under construction; by use of three motors the speed has been increased to 45 miles an hour. Seven foreign nations have ordered Parsevals.

The writer concludes that German airship construction is in a strong position at the beginning of 1913.

"E."

REVUE D'ARTILLERIE.

September, 1912.

STUDY OF THE EFFICIENCY OF FIRE.

Efficiency of Shrapnel.—The author first defines what he means by efficiency, and then proceeds to investigate mathematically the efficiency of the 75-m.m. gun. He traces the trajectory of the balls, and the best height for bursts, the trace of the cone on the ground, and the dispersion of the balls. He then gives the efficiency against men standing, kneeling, and lying, and the numbers of double hits on ranks behind each other. He obtains one thousandth of the range as the best height for bursts when ranging, and three thousandths for efficient fire; it should be somewhat less up to 3,000 metres range, and rather more at longer ranges. The following principles are deduced (of which the 2nd and 3rd appear contrary to generally accepted ideas):—

(1). Fire against close formations acquires its maximum efficiency at about 2,500 metres range.

(2). The mean percentage falls rapidly as the number of ranks increases.

(3). Efficiency against close formations is very notably inferior to that obtained against troops in open order.

The article is to be continued.

LIGHT MACHINE GUNS AND REPEATING RIFLES.

Tactical necessities exact extreme mobility in machine guns, hence the conception of a new arm, the repeating rifle. The automatic rifle is the simplest expression of this arm. Dirigibles and aeroplanes demand an arm of this kind. The rapidity of fire approaches 250 shots a minute. The weapon is supported on a fork to steady the aim and fired from the shoulder. Denmark and Russia have already adopted the automatic rifle, and its advantages and inconveniences are discussed, and a photograph is given of a Danish Hussar armed with one.

THE LIGHT VICKERS MACHINE GUN.

A new weapon based on the Maxim, but weighing only 12¾ k.g. against 27 k.g. for the latter. A general description is given, and the

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action, methods of feeding, firing and ejection of the fired cases are explained. The water jacket holds 7½ pints. The newest carriage is the adjustable tripod, of which there are two types, Mark E being provided with an axle and wheels for man haulage, and Mark F being merely a tripod stand intended to be carried by man or horse. Five good photographs are published, also three plates with 25 figures.

ARTILLERY ENGINEERS.

A further contribution towards the discussion of this subject.

October, 1912.

PIEDMONTESE ARTILLERY INVENTIONS OF THE 18TH CENTURY.

The adoption by Italy of a new field gun recalls the fact that in the 18th century the Piedmontese already had breech-loading guns, cartridge and projectile in one, and guns resting in cradles. This article is borrowed from the *Rivista di Artiglieria e Genio*, and describes the guns invented by Chieppo, Genner, Bertola and Salmour. Of historical interest only.

LIGHT MACHINE GUNS, AND REPEATING RIFLES.

The Danish Schouboe repeating rifle is described, with two plates and several figures. 500 rounds can be fired per minute, but normally only 200 are fired. The most serious defect of this weapon is the insufficiency of the cooling arrangements. Only 1,000 consecutive shots can be fired, it is better to fire only 500 and then change the barrel, which only takes 30 seconds. To each squadron of Danish cavalry is attached a section of three repeating rifles, carried by three troopers, with a fourth trooper leading a pack horse for the ammunition. The equipment, with weights, is given, and further photographs are reproduced. The Russians used a number of these weapons in Manchuria with satisfactory results. An extract is copied from the Russian Regulations, relative to the ballistic properties of the weapon.

VARIOUS INFORMATION.

Particulars are given of the field and mountain artillery and howitzers now being made use of by the five Powers at war in the Balkans.

November, 1912.

CONTRIBUTION TOWARDS THE HISTORY OF THE ARTILLERY.

The Responsibilities of the French Artillery in 1870.—The French artillery in 1870 showed itself far inferior, both in weapons and tactics, to that of the Germans. This inferiority is attributed on one hand to the necessity in the latter years of the reign of Napoleon III. for strict economy, and on the other hand to the discredit into which the Prussian artillery had fallen after the war of 1866. These two factors are discussed at some length with a view to extracting from them salutary lessons for the future. The history of the introduction of breech-loading, and of steel in place of bronze is also given.

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THE METHODS OF TESTING METALS AT THE CONGRESS OF NEW YORK IN 1912.

An International Association exists for the purpose of testing materials, and meets about every third year. It is divided into sections dealing with (1) metals, (2) natural and artificial stones and cements, (3) other materials. The previous meeting had been at Copenhagen in 1909. Resolutions passed at the latter gave a direction to the proceedings of the New York meeting. The account is divided as follows:—

Chapter I. Objects for research established by the Congress of Copenhagen in 1909.

Chapter II. Summary of the principal results presented at the Congress of New York in 1912.

Chapter III. General resolutions passed on the subject of various questions submitted to the Congress.

Chapter IV. Conclusions affecting the tests to be applied in artillery laboratories.

The account is somewhat technical, and deals only with the metal section, but would be of considerable interest to anyone dealing with the properties of metals.

VARIOUS INFORMATION.

A short account is given of the German field howitzer, called the field howitzer 98/09. The sight has seven graduations for distance corresponding to seven different charges. The battery consists of six howitzers, and 154 rounds per gun are carried. The Swiss artillery is to be increased by 12 batteries of howitzers of four guns each, 12-c.m. Krupps, also by three mountain batteries of 7·5-c.m. Krupps. The former carry 600 rounds—shrapnel and shell—and the latter 900 rounds per gun. The fortress artillery in the fortifications of the St. Gothard and St. Maurice are to be supplied with mobile fortress guns, consisting of 12-c.m. howitzers and 7·5-c.m. field guns. The first issue will be 26 howitzers and 30 guns.

December, 1912.

STUDIES OF FIRE EFFICIENCY.

The last of a series of articles by General V. Tariel. The results of experiments are compared with the results calculated from his formulæ, and are found to agree very closely for infantry standing in dispersed order. Owing to the difficulty of arranging figures to represent them sufficiently accurate, experiments against troops lying down and in close formations, and also against artillery, could not be properly carried out.

Influence of Slope of Ground.—The influence of the slope on the efficiency of fire varies according as the slope falls to the front or rear.

Slope Falling to the Front.—For the same height of burst, up to 3/1000 of the range the total mean efficiency of single shots is practically the same as on the flat. For heights of burst greater than that the efficiency increases as the slope increases. With searching fire it is different, for the successive salvoes tend to burst on impact, this tendency increasing with the slope. The general rule for efficiency on slopes greater than 1/20 is to increase the corrector by 2/1000 after each salvo up to 3,000 metres range, and by 1/1000 only for greater ranges.

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Slope Falling to the Rear.—Searching fire is efficacious on slopes less than 1 in 20. The third salvo produces little effect on a slope of 1 in 10, and is useless on a slope of 1 in 7. On a slope of 1 in 5 searching fire is useless. Happily this is not actually true, it is the regulations that are wrong. Instead of arranging for searching fire by increasing the angle of sight it should be done by diminishing the corrector by 2/1000 after each salvo.

Two questions still present themselves. How can the steepness of the slope be judged, and what range should be taken. The first question can be answered by enclosing the crest in a 100-m. bracket and then increasing the longer range by 100 m. If percussion shrapnel raises dust the slope is not over 1 in 20. If the smoke only is visible, and after some delay, the slope is greater than 1/20, but generally less than 1/10. If the shot cannot be seen at all the slope is steep. The answer to the second question is stated to be for all ranges and all slopes, 100 metres beyond the crest.

For efficient searching fire the following should be the method employed :—

Obtain a 100-metre bracket enclosing the crest.

First salvo the short range of the bracket, corrector $\frac{3}{1000}$.

Second salvo the long range of the bracket, corrector $\frac{3}{1000}$.

Third salvo the long range of the bracket increased by 50 metres, corrector set at $\frac{3}{1000}$.

Fourth salvo, the same range, corrector diminished by 2.

Fifth salvo, the same range, corrector diminished by 2.

If after the fourth salvo it is seen that the shots tend to burst on impact give 50 metres more elevation.

It should be noted that slopes cannot be efficiently searched when their slope exceeds the angle of descent of the projectile.

The French field gun is then compared with the German 77-m.m. gun as far as data are available for calculating the efficiency of the latter. The results are tabulated, and the following conclusions drawn. The German shrapnel has 10 balls more than the French, but each of the 300 German balls of 10 grains each is less effective than the 12-grain balls of the French shell. Firing on a zone and front of 100 metres the two projectiles are practically equal. On a contracted zone and front the superiority of the German shell increases as the front diminishes, especially against men lying down and close formations. This superiority is the result of the greater inclination of the shell at the moment of burst, and of the smaller cone of dispersion. But the surface of ground efficiently beaten by a single round is notably smaller, one-third or less, than that beaten by the French shell. The less flat trajectory, besides, facilitates fire from concealed positions and fire behind crests on sloping ground is more efficient. It follows therefore that in action behind the same crest as the French gun, and firing at the same mark, it can take better cover. For the same mark, and with the same cover, it can search slopes one-third greater. For the same ground, and with the same cover the dead ground is sensibly less. For example, when the French gun can only fire at beyond 2,000 metres, the German gun can

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begin at 1,600 metres. Therefore coming into action is easier with the German gun. From this comparison it appears that there is not so much advantage as is generally supposed in a very high initial velocity, and that for a field gun a velocity of 475 metres is ample. This would enable weights to be decreased, simpler arrangements for checking the recoil, with possibly less slaughter.

Fifteen tables referred to in the foregoing articles are published at the end.

A CONTRIBUTION TOWARDS THE HISTORY OF THE ARTILLERY—THE RESPONSIBILITIES OF THE FRENCH ARTILLERY IN 1870—BREECHLOADING AND STEEL GUNS.

An account of the difficulties experienced in finding a good breech mechanism before and after the war of 1870–71, and of the opposition to the substitution of steel for bronze. The article is historically interesting and is to be continued.

FIELD ARTILLERY AT THE GERMAN MANŒUVRES OF 1911.

A summary of the most interesting portions of the second of three articles published in the *Artilleristische Monatschefte* for November and December, 1911, and January, 1912.

I. Artillery Positions.

(*a*). *Covered Positions.*—A very convenient method has been evolved for bringing batteries into action. The group commander points out to the battery commanders a reference point (*Hauptrichtungspunkt*) by which the batteries generally place themselves in parallelism. (The word *Hilfsziel*, aiming point, seems reserved for the case where the battery commander, though employing direct laying, prefers to point out to the layers a more visible point). The battery commander rides to the front of the centre of the site for the battery, places the *cercle de pointage No. 1*, and points out the reference point to the N.C.O. in charge. The N.C.O. i/c *cercle No. 2* proceeds behind the centre of the site and fixes his instrument, and the flanks of the battery are marked by coloured pennons. The pennons are pointed out by the trumpeter to the officer leading the battery, whose work is thus simplified. The time taken from unlimbering to firing the first shot never exceeded four minutes. Two possible objections to this method are stated and discussed, and decided to be baseless.

All battery officers should be trained to bring the battery into action calmly, keeping under cover and avoiding dust. The writer recommends coming into action in column of sub-sections to avoid collisions between the advancing wagon, and the retiring gun limber. He states that he never saw a sign of one of the enemy's batteries coming into action, and would never have found out their positions at all except by hearing them fire, if it were not for the wretched red flags they hoist to designate that they are firing. Everyone agrees that these flags should be done away with. The projectors tried in 1908 to send a beam of light towards the unit on which they were firing had also the same defect. He recommends a battery firing one shot to show that its target is artillery, two shots for

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infantry or columns on the march, etc. On one occasion a ladder observatory was seen very indistinctly in some trees. The year before several battery sites had been given away by the staffs, this year there was nothing of that sort.

(*b*). *Open Positions.*—Twice only during the manœuvres were open positions taken up, and then only during a pursuit against columns of infantry in retreat, and they were covered from the enemy's artillery. Direct laying was not employed owing to the difficulty experienced in pointing out the objective to the layers. Even in open positions the observing wagon should be taken to the battery commander, and not placed in battery behind the centre of the front.

(*c*). *Positions in Observation and in Readiness.*—The new French regulations give the preference to positions in observation over positions in readiness. They have doubtless recognized, as we do, that a position in readiness behind the position to be occupied generally only results in waste of time, since at the moment when its intervention is necessary the battery has still to come into action and get ready to fire.

II. Intercommunication.

It is necessary to distinguish between technical and tactical communications. The former shows batteries *how* they should fire, the latter *on what* they should fire according to the general plan. Artillery officers are never now seen sending back information from the infantry firing line, the prismatic telescope supplies the technical communication.

The experience of the manœuvres makes it clear that tactical communication should be from the chiefs of the various arms to their subordinates, and should also be from front to rear, and not *vice versâ*. It is noticed that the artillery are always directed to keep in communication with the infantry, but as the infantry are ahead they can often give useful information to the artillery, and should be trained to do so.

III. Tactics.

In this chapter the author expresses his personal ideas on artillery tactics. One is that the brigade commander should remain near the divisional general to advise him as to the employment both of the batteries in action, and of those in reserve. The beginning of an action by the artillery duel is out of date, grand batteries are no more, and the largest unit that would be employed together is the regiment. Another important modification in the regulations should be to abolish the rule that a numerical superiority in guns should be established from the first. This part of the article is not reproduced, a great deal of it being in direct contradiction to the German regulations.

Matériel.—The author inveighs against the minute instructions given in the confidential pamphlet *Das Feldartilleriegerät* as tending to introduce an unjustifiable mistrust in the *matériel*. Accidents are not common. It is not correct to say that the observatory wagon is too heavy for four horses. The fact is, that in changing position, the battery does not wait for the observatory to be dismantled, and the latter has to come on afterwards. The ladder observatory can be concealed in trees, and has never

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disclosed the position of a battery in these manœuvres, but in bare country, such as parts of Lorraine, it should be replaced by dismountable masts. The telephone worked well, but a man with a spade should follow up the wire to bury it where it rises above the ground. Horses damage it less than foot passengers. The *cercles de pointage* (*Richtkreise*) and the *lunette à oiseaux* (*Scherenfernrohr*) gave every satisfaction. Of the latter there should be a spare one with each battery, and its place should be on the ladder observatory, or on the wagon body and not on a tripod. The portable shield, behind which it is sometimes placed, protects the battery commander but badly, and gives no protection to his assistants, telephonists, etc. A panoramic telescope, allowing of the easy resolution of the problems for opening fire, should be supplied for the field gun. The present sight does not allow of firing on an aeroplane. The deflection scale allows of insufficient adjustment to follow an object moving at right angles to the line of fire at long ranges.

Equipment.—The author finds the artillery saddle (*Bocksattel*) deplorable, and recommends the issue of the general service saddle (*Armeesattel*). The grey (*feldgrau*) uniform is excellent and very invisible.

Armament.—The issue of a carbine to all N.C.O.'s and men is advocated.

The author concludes with congratulations on the progress made, but bemoans the constant dearth of officers.

A.R.R.

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CORRESPONDENCE.

DEMOLITION OF HIGH WIRE ENTANGLEMENT.

DEAR SIR,

The failure of an experiment in cutting a wire entanglement by means of explosives, as related in the February number of the *R.E. Journal*, 1913, may have raised doubts in the minds of some as to whether the operation is feasible.

The experiment appears to have been based on some experiments carried out by a Russian Engineer officer, who adopted the method described in the French "Instruction sur les procédés de franchissement et de destruction des obstacles de la fortification," a transcript of which was given in the *R.E. Journal*, June, 1912. The charge recommended by the latter instructions is one of melinite—99 "pétards" to 5 metres, or 1·8 lbs. per foot-run, the equivalent of which in guncotton is, according to "Mining and Demolitions, 1910," about 2·4 lbs. per foot-run.

The charge used in the Russian experiments was about 2½ lbs. per foot-run, of pyroxiline or guncotton, or almost exactly that adopted in practice by the French.

It seems probable, therefore, that the failure of Capt. Bushell's experiment (using 1⅓ lbs. per foot-run) was due to too small a charge being used.

As far as the writer's experience goes, it is not possible to rely on a perfectly clear gap being made, but the few wires remaining uncut would be easily severed by the wire-cutting party.

Yours faithfully,

E. ROGERS,

Capt., R.E.

Gosport, 21st February, 1912.

The Editor, *R.E. Journal.*

ECONOMY IN CONSTRUCTION.

DEAR SIR,

Re the correspondence appearing in the January issue of the *Journal* under the above heading, I confess to having overlooked all considerations other than those brought to light by the recorded behaviour of bridges subject to live load and impact during the last 50 or 60 years. The case of the Britannia Bridge, cited in my article, which without any allowance for impact was stressed to 7 tons per square inch 50 years after erection, is surely sufficient evidence that its "molecules," in spite of the theoretical canons of molecular etiquette described by your

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correspondent, made light of the troublesome business of "rearranging themselves.' Another example is afforded by the old Arpley Railway Bridge over the Mersey at Warrington, which had been in continuous use for over 55 years before reconstruction. Test pieces cut from members calculated to have been stressed to 7 or 8 tons in ordinary practice, and occasionally more, showed no discoverable deterioration, although the material was wrought iron and not steel. Moreover when the reconstructed bridge was completed, no tests under moving load were carried out, the Board of Trade being quite satisfied with static load tests.

I am speaking without the book, and perhaps your correspondent will correct me if I am wrong, but I believe the Board of Trade has issued no regulations on the subject of Impact. They confine themselves to laying down 6½ tons as the limiting stress, and this rule was enacted in 1877, or *36 years ago,* since when the ultimate strength of steel has no doubt much improved.

I have before me some plans of road-bridge girders, spans 40 ft. to 200 ft., designed by a Canadian firm to the specifications of the Dominion Government. Taking a few members at random I find that they are stressed to 8 tons per square inch, again without any allowance for impact or moving load. Bridges built to these designs may be seen anywhere in Western Canada, Winnipeg, Calgary, British Columbia, or Vancouver Island, so their strength cannot reasonably be questioned.

Sir Bradford Leslie, the eminent bridge designer, writes "In the early days, girders (which are still carrying 90 per cent. of the traffic) were designed without allowance for impact, and if they are unreliable they should all be condemned forthwith: that would indeed be a jubilee for bridge builders!"

If the book mentioned by your correspondent recommends a "mathematical factor" of 2 in. for live loads on permanent bridges, (temporary military bridges built under service conditions, were outside the scope of my article) the necessity for its revision, to bring it into line with modern engineering practice all the world over, at once suggests itself.

Yours truly,
E. ST. G. KIRKE,
Lieut., R.E.

The Editor, *R.E. Journal.*

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BOOKS RECEIVED.

WIRELESS TELEGRAPHY AND TELEPHONY. By Wm. J. White, A.M.I.E.E. 100 illustrations. Second edition. Revised and enlarged. 2s. 6d. net. Whittaker & Co., 2, White Hart Street, Paternoster Square, E.C. 1912.

MAGNETO AND ELECTRIC IGNITION. By W. Hibbert, A.M.I.E.E. 2s. net. 99 illustrations. Whittaker & Co., 2, White Hart Street, Paternoster Square, E.C. 1912.

ESTIMATING FOR REINFORCED CONCRETE WORK. By T. E. Coleman. 4s. net. B. T. Batsford, 94, High Holborn, W.C. 1912.

SPONS' PRACTICAL BUILDERS' POCKET BOOK. A Reference Book of Memoranda and Tables for Architects and Builders. Edited by Clyde Young, F.R.I.B.A., and Stanford M. Brooks, Licentiate R.I.B.A. 74 illustrations. 5s. net. E. & F. Spon, Ltd., 57, Haymarket, S.W. 1913.

SPONS' ARCHITECTS' AND BUILDERS' POCKET PRICE BOOK AND DIARY, 1913. Edited by Clyde Young, F.R.I.B.A., and Stanford M. Brooks, Licentiate R.I.B.A. Fortieth edition. Price, 2s. 6d. net, postage 2d. extra. E. & F. Spon, Ltd., 57, Haymarket, S.W.

HOW TO ESTIMATE. BEING THE ANALYSIS OF BUILDERS' PRICES. By J. T. Rea. Fourth edition. Over 400 illustrations. B. T. Batsford, 94, High Holborn, W.C. 1913.

WITH THE VICTORIOUS BULGARIANS. By Lieutenant H. Wagner, War Correspondent of the *Reichspost*. 55 illustrations and map. 7s. 6d. Constable & Co., 10, Orange Street, Leicester Square, W.C.

PEINE PERDUE ET TEMPS GÂCHÉ. NOTES À PROPOS DE L'INSTRUCTION DES CADRES. Capitaine G. Cognet. Paris. 1912. Chapelot. Prix, 2 fr. 50.

L'APPRENTISSAGE DE LA GUERRE. Colonel Gory. Paris. 1912. Chapelot. 134 pages. Prix, 2 fr. 50.

ENCORE QUELQUES IDÉES SUR L'ARTILLERIE. Colonel Potel. Paris. 1912. Chapelot. 91 pages. Prix, 1 fr. 50.

NOTE POSTHUME SUR LES GRANDES MANŒUVRES DU 6e CORPS EN 1888, suivie de CONSIDÉRATIONS SUR LA TACTIQUE ACTUELLE, par le Général Bonnal. Général Maillard. Paris. 1912. Chapelot. 59 pages avec 2 cartes hors texte. Prix, 1 fr. 50.

QUELQUES IDÉES SUR LA GUERRE DE PLACE. Colonel J. Rouquérol. Paris. 1912. Chapelot. 36 pages. Prix. 0 fr. 60.

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LA POLICE MILITAIRE. Capitaine Favre. Paris. 1912. Chapelot. 16 pages. Prix, 0 fr. 30.

INSTRUCTION MÉTHODIQUE DES CADRES ET DES ÉLÈVES CAPORAUX. Lieutenant Biétron. Paris. 1912. Chapelot. 71 pages. Prix, 1 fr. 50

ÉTUDE SUR LA CONSTITUTION D'UNE RÉSERVE DE TIRAILLEURS ALGÉRIENS. Capitaine Caré. Paris. 1912. Chapelot. 16 pages. Prix, 0 fr. 30.

REMARQUES SUR LES FACTEURS DE L'AVANCEMENT DES CHEFS MILITAIRES. Capitaine F. de l'Harpe. Paris. 1912. Chapelot. 22 pages. Prix, 0 fr. 50.

NOTIONS SOMMAIRES SUR LES CHEMINS DE FER, *à l'usage des officiers et sous-officiers* du service de garde des voies de communication. Par A. Laplaiche, contrôleur général de l'exploitation commerciale des chemins de fer. 1913. Berger-Levrault, 5—7, rue des Beaux-Arts, Paris. Prix, 2 francs.

FRANCE ET ALLEMAGNE. LA GUERRE ÉVENTUELLE. Lieut.-Col. Grouard. Paris. 1913. Chapelot. Prix, 3 fr. 50.

LA GUERRE TURCO-BALKANIQUE, 1912. Thrace—Macédoine—Albanie—Epire. (Avec 11 cartes en couleurs hors texte et 10 croquis dans le texte). By Lieut.-Col. breveté Boucabeille. Paris. 1913. Chapelot.

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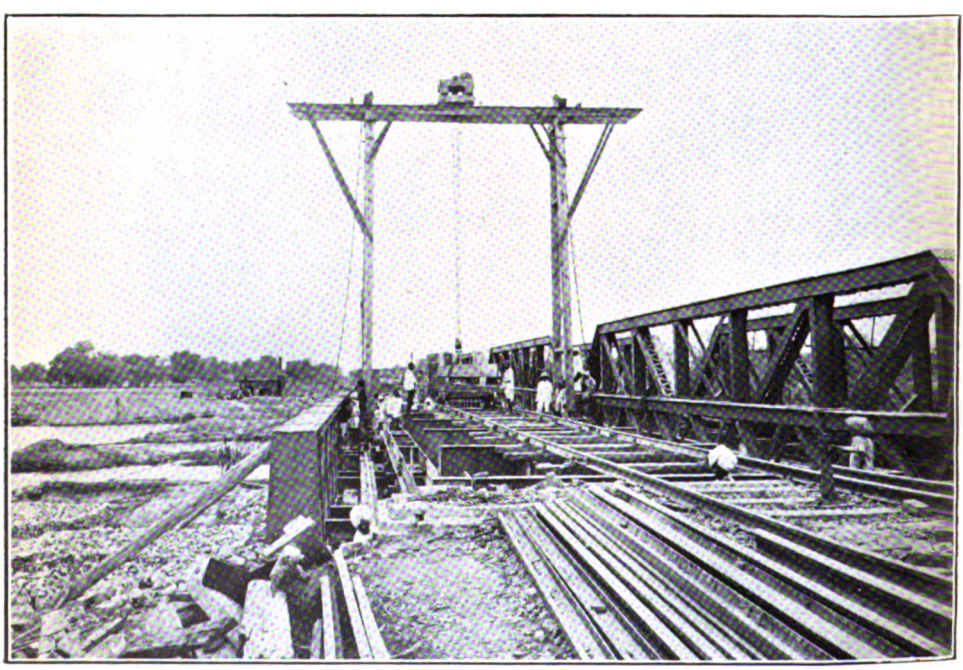
THE WEST BEYNE BRIDGE.

The completed "down" line bridge.



Erecting the new girders on staging carried by the old ones. New bottom booms and cross girders almost complete.

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THE WEST BEYNE BRIDGE.

By Capt E. P. Anderson, R.E.

The recent increase of traffic on Indian railways, due to the rising prosperity of the country as a whole and more particularly to the large exports of grain, has rendered necessary a considerable amount of work in the improvement of the existing railways with the object of increasing their carrying capacity. This has been done by doubling existing single lines where traffic was very congested, and strengthening the road so as to take heavier engines and correspondingly increased train loads.

The N.W. State Railway has proved no exception in this matter. It forms the main link between Delhi and every part of the North-West Frontier, and also provides by its line to Karachi the outlet for the export of wheat produced in the great irrigated areas of the Punjab, so that improvements, such as those referred to, have there a double value from both the strategic and commercial points of view. The doubling of the line and replacement of the old girders of the West Beyne Bridge, which are dealt with in this paper, formed part of a considerable scheme for such work recently carried out between Amritsar and Umballa on the Delhi-Peshawur main line.

The West Beyne is a tributary of the Beas, which rises in the foothills of the Hoshiarpur district. At the point where the railway crosses it, some 15 or 20 miles above its confluence with the Beas, there is no appreciable watershed between them, and twice at least since the construction of the line in about 1870, a stretch of country some 6 miles wide has been flooded by the Beas, and most of the bridges on this length of line have been completely washed out. The exact records of this bridge are most incomplete, but during the progress of the work now described remains of old foundations were discovered, from which it is surmised that the original bridge was one of two spans of about 100 ft. each, and that it was subsequently increased to three and later to four such spans, as now exist. To prevent further damage by scour, large quantities of loose stone, in pieces about the size of a man's head, had been deposited round the piers, a method of protection not altogether in accordance with modern views on the subject, and one which caused some little trouble in carrying out the extensions of piers and abutments.

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The piers of the old single-line bridge were each founded on two wells of 13 ft. diameter and of unknown depth, and were not long enough for the second track. It was therefore decided first to lengthen them in the upstream direction and complete the girders for the new track, and then to divert the single-line traffic over this while the old girders of the original single line were being replaced. The new track thus formed the "down," and the old one the "up" line of the reconstructed bridge.

In designing the doubling of the bridge five possible methods were considered :—

1. Open foundations on concrete close to the old wells.
2. Well foundations on the ordinary Indian method close to the old ones.
3. Foundations similar to the above but sunk by the compressed air method.
4. Reinforced concrete piles driven close to the old wells.
5. The construction of a separate bridge for the new down line at a distance of 100 ft. or so upstream from the existing one.

Of these alternatives Nos. 1, 2, and 3, were considered impracticable owing to the risk of a "blow" causing settlement of the existing piers, over which traffic was running all the time. No. 2 was also impossible owing to the presence of the pitching stone round the old piers, which would have made well sinking most difficult if not altogether impossible, as isolated stones are met with at all levels below the bed and might cause the wells to tilt out of the vertical.

The construction of a separate bridge (No. 5) would have been a quicker plan as things actually turned out, but was vetoed on the ground of the sharp reverse curves in the main line which it would have necessitated, owing to the length of line available for them being limited by two long arched viaducts, one on each side, which were already well in hand. For a line on which speeds up to 60 m.p.h. are obtained this objection is a serious one.

Alternative No. 4 (reinforced concrete piles) was therefore adopted, and it is believed that this is the first large railway bridge in India where this method of making the foundations has been entirely used.

In August, 1908, the manufacture of the piles was started. The design adopted was square in section to facilitate moulding. The piles were 14 in. square outside, reinforced with four longitudinal mild steel bars $1\frac{1}{2}$ in. in diameter, whose lower ends were bent in to meet the forged shoe. The bars were held apart by cast iron I shaped struts at intervals of 2 ft. 6 in. which were merely used to prevent their displacement during the ramming of the concrete. Transverse rein-

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forcement was given by welded links of ¼-in. diameter wire at a spacing varying from 1½ in. to 3 in. In the later design of piles this type of transverse reinforcement was abandoned owing to the large number of defective welds which were found in the links on test, and to the difficulty of getting the links made of exactly equal size, which resulted in their becoming loose and displaced during the ramming of the concrete. As a substitute for the links it was arranged to make the transverse reinforcement by winding the wire on to the longitudinal rods in continuous lengths. A tight spiral was first of all wound on a hand winch with an extemporized square barrel of a size exactly equal to the outside dimensions of the reinforcement. This was then slid over the longitudinal rods, spread to the required pitch (1½ in. over a length of 2 ft. 6 in. at each end and 3 in. in the middle of the pile) and the whole tightened up by the insertion of the cast-iron struts. The longitudinal rods were bent inwards at the foot of the pile to rest on the forged shoe, which was also held in place by arms which projected into the concrete.

The reinforcements for the piles were thus made in the form of rigid skeletons which could be conveniently handled and placed in the moulding boxes. These boxes were made of deodar in five pieces, viz., two sides, a bottom, and two ends. The sides and bottom had wedge-shaped pieces nailed to them to mould the taper portion of the lower end of the pile. The piles, which were 27½ ft. long, were moulded horizontally and no defects were noticed on this account. The sides and bottoms of the boxes were held together by an arrangement of iron clamps secured with small bars and cotters. As they get very rough usage, screws or nails are quite unsuitable for this purpose. Great economy can be obtained by making such moulds substantial, so that they can be used over and over again, as was done in this case, and it certainly pays to make them of good material and ample thickness. In this case the planking was 1½ in. thick, which is fully light for such work; 2 in. would have been better. Before placing the skeleton in the box all parts of the latter in contact with the concrete were painted with a wash made of two parts by weight of white lime (as used for whitewashing), and one part of soft soap, mixed with water to a thick creamy consistency. This was quite effective in preventing the cement from adhering to the wood.

The materials for the concrete were a source of a good deal of trouble, largely owing to the lack of practical experience on the part of the staff concerned. There is no doubt that only the very best of everything will do for such work, and it is useless to attempt it otherwise. The first large consignment of English Portland cement received gave such unsatisfactory tests at the site

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of work, that a complete analysis and test by an independent expert in accordance with the British Standard Specification was ordered. The result was so unsatisfactory that the cement was condemned and much valuable time was lost in purchasing a supply of satisfactory quality in India. This is not an isolated case within the author's experience, and the subject of cement for use in India is of such importance to engineers, especially in connexion with reinforced concrete structures, that no excuse is offered for a short digression on the subject.

No cement is fit for use in important work which does not *at the time of actual use* comply fully with the British Standard Specification, which may be regarded as an absolute minimum; many makers now produce cement which far exceeds its requirements. Samples on which the acceptance of a consignment depends are usually tested at home before shipment. But there seems little doubt that changes take place, even where the barrels are treated with unremitting care, during the period of six months or more which elapses between the manufacture of the cement and its use in India. For use in tropical climates, especially dry ones like the Punjab, cement must be "slow setting." This is sometimes, apparently, attained by the addition of gypsum during or after manufacture. There is some reason to suppose that the effect of this gypsum wears off in a few months, the cement returning to the state of a "quick-setting" one, and then maturing later in the usual way to become again "slow setting" after a further lapse of time without any aeration or treatment whatever. The moral seems to be to exclude by specification the addition of gypsum, and in addition to the usual tensile tests at site of work, which in inexpert hands may give erroneous results, to make careful tests for setting time and soundness by any of the recognized methods. Those given in the British Standard Specification are easily carried out, though the prolonged boiling of a briquette, or thin pat, is considered by some authorities a more sensitive test for soundness than the Le Chatelier method. For reinforced concrete work it need hardly be urged that an absolutely "sound" cement is a *sine qua non*.

Aeration of cement at site of work in India is of doubtful utility, considering the length of time which necessarily elapses between its manufacture at home and use in India. If samples taken straight from the barrels give satisfactory results on test, it will probably be better to use it straight from the barrel without any aeration whatever. If the samples appear unsound it may be improved by aeration; while if the cement is too quick setting, it seems quite as likely to improve by storage for some months in the barrels as by aeration for any period.

The sand at first used in this work was obtained locally at Hamira.

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It was a very fine river sand with a good deal of earthy and micaceous matter which repeated washing did not entirely remove. The resulting concrete in the first piles tested was found to be spongy and unsatisfactory in consequence, and the use of this sand had to be abandoned. After examining samples from several different localities, it was found necessary to import soft sandstone from the neighbourhood of Delhi, and to produce a satisfactory sand by passing it through a Carter's disintegrator and then twice screening the result, the portion used being that which passed a screen of $\frac{1}{8}$-in. mesh and was retained on one of $\frac{1}{30}$ in. Latterly the stone-breaker established at the ballast siding at Pathankot was found to produce an excellent sand for the purpose, clean, sharp and of suitable size. The broken stone used was obtained by breaking up boulders taken from the bed of the Chakki River at Pathankot. This was at first done entirely by hand, a slow and expensive method even with the relatively cheap labour available. During the progress of the work a Baxter stone crusher was established there, which produced admirable material. The stone had to pass a $\frac{1}{2}$-in. screen, and round pebbles from the river bed were rigorously rejected. The material used in the reinforcement was ordinary mild steel bars and wire.

The proportions of the materials originally used in the concrete for piles were 1 : 2 : 4, the percentage of voids in the aggregate unrammed having been found by experiment to be about 44. But experience showed that, with the limited amount of ramming possible owing to the closeness of the spacing of the reinforcement, the resulting concrete was not quite so solid as could be wished, and the proportions were altered to 1 : $1\frac{1}{2}$: 3 which gave entirely satisfactory results. The quantity of water used with the concrete was also the subject of experiment. It was found that a distinctly wet mixture gives the best results as it flows most easily into the interstices of the box and reinforcement, and results in sounder work. It was fixed at 12 gallons per c. ft. of cement.

The mixing and laying of the concrete was carried out entirely by hand, labour being relatively cheap. A dry brick floor was made, on which the boxes were laid. The ingredients were measured out in boxes of 1 : $1\frac{1}{2}$ and 3 c. ft. capacity respectively, and placed in separate heaps. A box of sand and one of cement were then mixed together dry by turning over with a shovel, and placed on the top of the corresponding boxful of broken stone which had been previously slightly damped to reduce its temperature. This heap of dry ingredients was then twice turned over with shovels, the measured quantity of water added from cans with fine roses as the materials were being turned over a third time, and the wet concrete was again turned over twice. Each boxful of stone with its corresponding cement and sand was treated separately, and not wetted till the

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previous one was almost used up, to ensure the concrete being finally laid and rammed before any setting action had started. The wet concrete was carried by coolies in iron mortar pans to the pile boxes, deposited by them, and then rammed by a specially trained gang of six men, the whole work on each pile being pushed through as fast as possible so as to let no part of the concrete be disturbed more than 20 minutes after it was first wetted.

After moulding, the piles were covered with sand kept very wet for a week, at the end of which time the sides of the boxes were removed. At the end of four weeks from first moulding the pile was rolled over sideways by a gang of about 25 men and the bottom of the box removed. The manufacture was always so far in advance of the driving that the piles were not used for two or three months after manufacture, though they appeared quite fit for use after six weeks. The piles were made and allowed to set in a shed made of thatch with all its sides quite open. This was necessary in order to prevent the concrete being spoiled during setting by the high temperature of the direct rays of the sun.

After a number of piles of the original type had been made and matured experiments were made in driving them. The only steam pile driver obtainable had a 1-ton monkey and was of a very old pattern made by Sisson & White. Driving was tried both with and without a helmet to protect the head of the pile, and in both cases resulted in a failure. The pile heads cracked very badly before the pile had penetrated more than a few feet in each case. This was principally due to the fact that the monkey (1 ton) was so light in comparison with the pile ($2\frac{1}{4}$ tons) that a very high drop was required to produce any effect, and this resulted in a shattering blow. The effect may be compared with what happens when one tries to drive a heavy picket into the ground with a light hand hammer instead of a heavy mallet or sledge hammer. The shattered concrete of the piles was also found to be rather porous, and it was decided to make the change in the sand already referred to. But although this was an undoubted improvement it is interesting to note that piles of the original pattern were later driven by the new pile driver with entire success.

No more powerful pile driver being obtainable in India, an urgent order was cabled home in July, 1909, for a new one of the Southgate pattern with a 2-ton monkey. Owing to most unfortunate delays in its manufacture, it only reached the work in May, 1910, just in time to be erected before the river came down in flood and stopped further work for the season. This pile driver works on the principle of an inverted steam hammer. Steam is admitted through the hollow fixed piston rod and raises the cylinder attached to the monkey, which falls by its own weight when steam is cut off by a

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hand-worked piston valve. The whole machine is carried by a frame attached to the steel helmet which rests on the pile head throughout the operation, thus subjecting the pile to this dead load all the time.

At the beginning of the cold weather of 1910 the necessary excavations and temporary dams were made, and actual pile driving started in October. Progress was very slow at first owing to lack of experience with this type of pile driver. The bolt through the helmet broke frequently owing to a slight movement of the latter under the blows. Even when this was corrected as much as possible by wedging the pile head tightly into the helmet with wooden wedges all round, these bolts never lasted for more than half-a-dozen piles. It is believed that the makers have since altered the design of this detail. The flexible steam pipe was also a source of trouble, as the india rubber perished very quickly. This was got over by the use of a flexible metallic pipe which stood very well.

Various parts of the pile driver were made of cast iron, a material quite unsuitable for a machine subject to sudden shocks. One of these was the shell of the main steam valve, which was twice replaced ; the last one, made by the Loco. Supt. of the line of a special gun-metal, stood admirably. A cast-iron guide block on the helmet was successfully replaced by one of hard wood, which was only renewed twice. A number of other minor failures occurred, which were repaired on the spot.

The steel helmet was divided into two parts by a horizontal diaphragm. The lower one fitted over the pile head, above which was a piece of wood about 3 in. thick faced with a $\frac{3}{8}$-in. steel plate next the pile. The upper portion was filled nearly to the top with sawdust over which was a hard wood block which took the blow of the monkey. This arrangement is most convenient as the sawdust does not need to be disturbed for each pile. Wedging the pile into the helmet with wooden wedges all round, referred to above, was found to be of the utmost importance. The wedges had to be tightened up at intervals during driving.

At first only one pile a day was driven owing to the difficulties referred to above. But after they had been surmounted the work was taken on contract by the headman of the Lascar gang employed on the work, and three piles were regularly brought to site and driven in a day. The damage to the pile heads was surprisingly small as may be seen by the *Photo.*

Before starting work at any pier, a trolly line was laid to bring the piles up to it, and as much as possible of the old pitching stone round it removed ; this enabled the piles to get a fair start, and if they met odd stones lower down no difficulty was felt in driving through or

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past them. The pile driver was carried on sleeper cribs which supported the baulks and rails on which it ran. It was fitted with an excellent steam winch, which lifted the piles into position, placed the pile driver on them, and after driving warped the whole machine along to the position of the next pile.

To get at the piers and one abutment which were not left dry in the cold weather, owing to the water being held up by an irrigation weir lower down the river, two dams were made above and below the bridge at a distance of about 100 yards. These were made by driving two rows of wooden piles 9 ft. apart, a distance about equal to the depth of water, and at intervals of 3 ft. or 4 ft., then laying a 6-in. thickness of brushwood on the surface of the water and tipping earth on top of it. The stream was very slow and this method proved quite successful. Owing to the irrigation weir the river normally has a very small discharge in the cold weather, and was diverted into a 15-ft. channel through the middle of one span. But in January, 1911, unusually heavy rain for the time of year caused a sharp rise, and the dams were washed away. This fortunately did not hinder the pile driving which was still going on at the east abutment. The dams were reconstructed in the same way as before but $2\frac{1}{2}$ ft. higher and proportionately wider, and in addition a central longitudinal dam was made by orders from headquarters with the object of localizing any further damage.

In March, 1911, the wisdom of this was apparent, for a record fall of rain—absolutely without precedent at this time of year—took place, the river rose to its summer level and half the dams were swept away. The central dam saved the pile driver which was then working at No. 3 pier. One of the traction engines used for driving the centrifugal pumps, which kept the space inside the dams dry, was cut off on the downstream dam and only saved by the hasty deposition by boat of a lot of sandbags round it to check the erosion. When the river fell it was brought ashore over a temporary bridge made with two old 30-ft. plate girders on sleeper cribs specially for the purpose. This flood made extensive changes in the channel, and the pile heads at No. 2 pier were found to be in 12 ft. of water (see *Plate*). A small dam had to be made, in a similar method to that already described, round this pier to complete the concrete slab and brickwork.

After completion of pile driving at any one abutment or pier, the heads of the piles were cut off to an exact level, their vertical rods being left projecting 1 ft. above the concrete. Over these was placed a frame of 12 in. × 5 in. steel I-beams, joined with riveted knees in each angle. The rectangles between the beams were filled with reinforced concrete slabs made *in situ*, the concrete completely surrounding all the steel of pile heads and beams. The bottom reinforcement of the slabs consisted of $\frac{3}{8}$-in. diameter steel rods spaced from $2\frac{1}{2}$ in.

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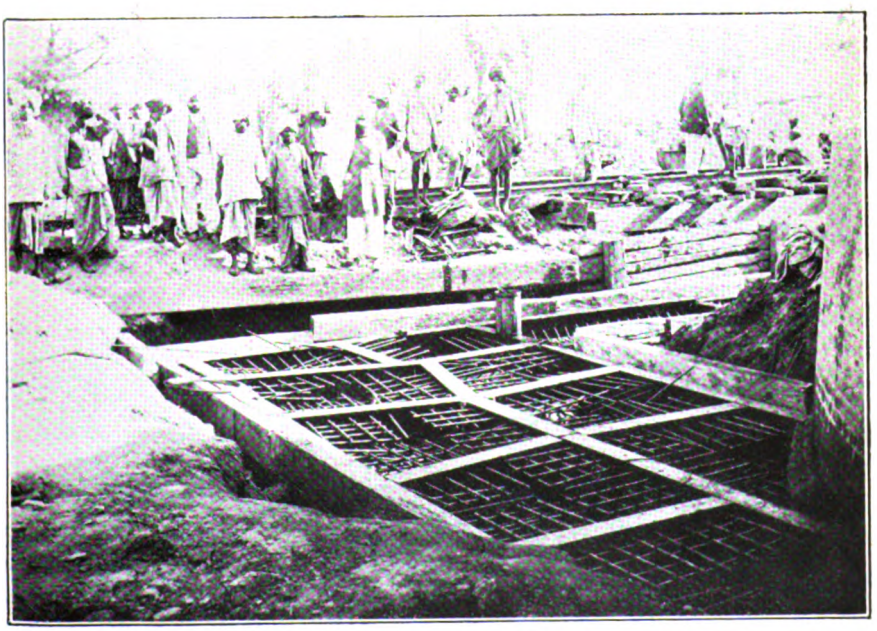
Pile heads after completion of driving.



Reinforcement for slab over pile heads at abutment ready for concreting.

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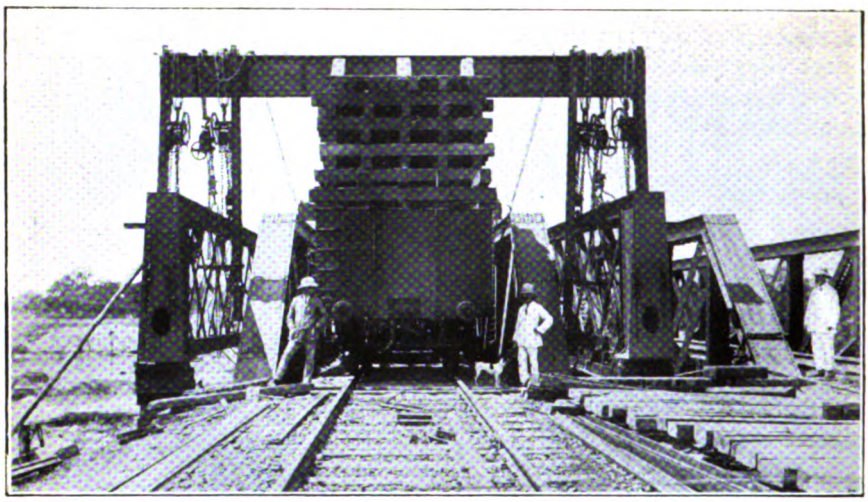
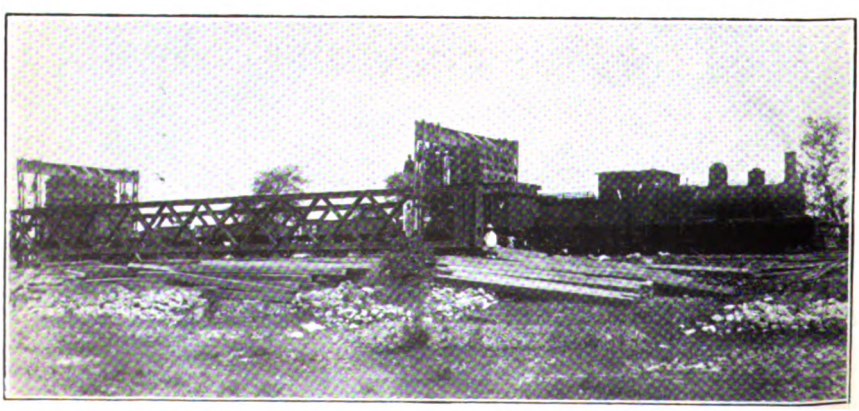
THE WEST BEYNE BRIDGE.



Old girders right up ready for travelling.

Ready to move the first span of old girders.



A span of old girders en route to Hamira.

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to 7 in. apart according to span, and owing to their being partially "fixed" an equal reinforcement was provided at the upper edge for 2 ft. 6 in. on each side of the beams. A short reinforced concrete cantilever of similar construction was made to carry the curved brick cutwater at the upstream end of each pier.

The concrete in these slabs was made in an exactly similar manner to that used in the piles, the proportions being 1 : 2 : 4. Mixing in small batches of 8 c. ft. or less was carried out by hand on a floor of dry brickwork as close as possible to the site. The mould for the slab was formed by laying a floor of old bricks round the piles and plastering it with the mud, cow dung, and chopped straw mixture, which is extensively used on inferior walls in India. This floor was of course never renewed. The sides of the mould were made of sleepers on edge secured to long pegs driven into the ground.

Brickwork on the piers was started a week after concreting, the slabs having been kept entirely under water in the interval.

Bedstones of Serai Kala limestone were used under the girder saddles in all cases except one. In this, the W. abutment, reinforced concrete blocks 4 ft. 8 in. × 4 ft. × 2 ft., with a double reinforcement of $\frac{7}{8}$-in. dia. rods spaced 6 in. apart, were used instead, owing to the contractor failing to deliver stones in time. These blocks were made *in situ*, and are apparently quite as satisfactory and cheaper than stones.

The loads on each of the piers, of which this completes the description, were as follows :—

	Tons.
Train load, including impact*	220
Girders	100
Ballast	50
Rails	26·5
Sleepers	4·5
Brickwork...	392
Total	793·0 tons.

Using 18 piles per pier, the load on each = $\frac{793}{18}$ = 44 tons. It was assumed that the load might be considered as evenly distributed over all the piles without sensible error in this case.

The bearing power of piles was calculated by Ritter's formula, as recommended in *Reinforced Concrete*, by Marsh & Dunn, whose methods of calculation were followed throughout the designing of the reinforced concrete work. The specification for driving of the

* Calculated according to Standard B of the Government of India Bridge Rules plus 25 per cent.

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piles was therefore that the average penetration per blow in the last five or ten blows with the 2-ton monkey and a 4-ft. drop, must not exceed $\frac{1}{10}$ in. With the factor of safety of 10 recommended, this gives about 48 tons per pile safe bearing power.

This appears to be well on the safe side, and it is probable that full-sized experiments would prove that a less severe specification would be quite safe enough. But such experiments would be a matter of great difficulty, in that some 400 or more tons of dead weight would have to be applied to each pile head and measured, and they were not for this reason attempted.

In several cases it was found that the required resistance was not obtained when a pile had been fully driven. Rather than delay the work by the time necessary to lengthen such piles, a second pile was driven at a distance of about 18 in. clear from the first. These second piles were usually found very "stiff" ones and no trouble was found in keeping them straight. A short piece of R.S. beam was fixed across the heads of such a pair of piles below the main frame, and by bringing the ends of the members of the latter on to its centre, the load was evenly distributed between the two piles. The R.S. beams were as usual covered in with concrete. The erection of the N type "through" girders, with trough flooring to carry a ballasted road, was carried out by means of Sullivan's staging. Where a bend of the staging, of which there were three per span, had to rest in the water, it was carried on six wooden piles 9 in. dia. driven "hard" by a hand-ringing engine with a monkey of about 1 cwt. Riveting was carried out entirely with compressed air plant, which has every advantage for this class of work. Its results can only be surpassed in India by hydraulic plant, which is difficult of application, or by the very highest class of skilled hand labour, which is not easily obtainable. The points requiring most attention are the maintenance of the air pressure at a minimum of 100 lbs. sq. in. at the hammers, and the proper heating of the rivets. If a contractor is employed he must be responsible for maintenance of the joints in the air-pipe, as leakage means a considerable waste of coal. The gangs employed consisted of

2 hammermen,
1 dollyman, using hand or pneumatic dolly,
1 heater,
1 boy to carry rivets,
1 ,, work air valve on main.

It was found economical to cut off the air supply to the hammers whenever any delay whatever occurred between successive rivets. The output of a gang as above varies enormously with the position of the rivets. In girders such as these the biggest joint has less than 100

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rivets on one side, so shifting furnace and pipe connections occupied a large proportion of the time, and an output of 100 per day was a good average. In straightforward work, such as the trough flooring, three times this may be expected.

In ordering and shipping girders in pieces from home, much trouble at site of work can be avoided if the following points are attended to :—

1. Paint all the parts of one span the same colour, and use a different colour for each span.
2. Stencil the name of the bridge on every piece or packing case containing its parts.
3. When sending girders forward by rail from port of arrival, try not to load parts of different colours or different bridges in the same truck.
4. Girder parts are often very roughly handled in transit, and strong protection of ends where joints have to be made is essential.
5. Rivets are usually $\frac{1}{32}$ in. less than the diameter of their holes. A bad contractor may easily use up more than the allowed percentage of spares, and a further supply has to be obtained in a hurry. This is much simplified if in the design rivets are used of the standard market sizes—*e.g.*, $\frac{5}{8}$ in., $\frac{7}{8}$ in., etc.—and the clearance given by drilling larger holes—*e.g.*, $\frac{21}{32}$ in., $\frac{29}{32}$ in., etc. If the converse method is adopted it may be found that rivet iron of the odd sizes, *e.g.*, $\frac{19}{32}$ in. to fit a $\frac{5}{8}$-in. hole or $\frac{27}{32}$ in. to fit a $\frac{7}{8}$-in. hole, is unobtainable at short notice.

II. Replacing the Old Girders.

The new down line bridge was completed and opened for traffic on 11th July, 1911, the single line being diverted over it. This left the old bridge clear for the work of replacing its girders. Owing to the lateness of the season it was considered inadvisable to use any false-work resting in the bed of the river for building the new girders ; floods were expected and might have caused a serious wreck. It was therefore decided to support the new girders on the old ones during erection, and then remove the latter.

The track and floor members of the old bridge were first removed by trollies to the west abutment (the new material being already stacked at the east abutment). A 12-in. baulk resting on the top booms with a block attached to its centre, through which the wire rope from the steam winch was led, served to lift the cross girders. But some little difficulty occurred at times in swinging the larger pieces back to the trolly, and it might be better in a similar case to

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make some provision for running the baulk on wheels along the top booms of the girders.

Sleeper crib extensions, filled solid with pitching stone, were made at the downstream end of each pier, resting on the stone pitching surrounding the old piers. When the floor system had been removed, each girder was raised about 6 in. by hydraulic jacks, and two well-greased rails were inserted under each end. The girder was then slid outwards by jacks working horizontally till it was 14 ft. 5 in. from the centre line, a distance sufficient to allow room for the erection gantry and the new girders inside the old ones.

The depth of the new girders being greater than that of the old ones necessitated the lowering of the bedstones on the piers, and of the old girders, whose bottom booms had to be about 3 ft. clear below the bottom booms of the new girders to allow for the supporting beams, camber jacks, etc. The lowering of the old girders was done by hydraulic jacks at each end. This operation required a good deal of care as a single girder is a very top-heavy load. They had to be very heavily guyed, and the guy tackles required constant tending as the girder was lowered. Three guys were used on each side, each consisting of a doubled 4-in. manilla rope, or a single $2\frac{1}{2}$-in. wire rope, controlled by a tackle attached to an anchorage of buried sleepers. It was found safer to lower one end of the girder at a time; a difference of level of as much as 18 in. between the two ends had no bad effect. It took a gang of 20 lascars one day to slide out and lower a pair of girders in this way.

After the old girders had been lowered till the downstream ones rested on the sleeper cribs referred to, and the upstream ones in recesses left for the purpose in the brickwork of the extension of the piers, temporary cross girders, formed from the double 12 in. × 6 in. I-beams of the Sullivan's staging, were fixed across their bottom booms. They were secured, by coach screws, to wooden blocks fitted tightly in the ⊔-shaped bottom boom of the old girders. On these were laid baulks to carry the travelling gantry and camber jacks, and erection of the new girders proceeded exactly as before. It should be particularly noticed that the extra time and trouble spent in lowering the old girders resulted in it being possible to build the new ones at their final level and alignment, and no jacking into position of the completed new spans was necessary, a process which is liable to slightly buckle the girders, apart from any difficulty in carrying it out.

On completion of the new girders and the track across them, the removal of the old girders was taken in hand. They had only to be removed a distance of a mile to a siding at Hamira, and it was decided to do this without cutting them up. To lift them up clear of the abutment and carry them away, two of the largest 4-wheeled

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high-sided trucks were borrowed from the Traffic Department, and sleeper cribs built in them, of a height sufficient to be clear above the tops of the new girders. Across each of these was put an old 30-ft. plate girder, spiked to the top layer of sleepers of the crib, and fitted on both sides with heavy timber struts, to prevent it capsizing. The whole was finally secured by a 2½-in. wire rope passed over the girder and under the truck floor, and tightened up with screw couplings on each side.

These two trucks were placed one at each end of the span, with three dummy trucks between them to preserve their spacing. From the ends of the 30-ft. girders differential tackles were slung by wire rope slings for lifting the girders. The slings were made by simply joining the two ends of a piece of wire rope with a single sheet bend, and seizing the loose ends carefully to the standing parts. This is quite a safe method for temporary use and much quicker than splicing.

The differential tackles were a source of much trouble and some anxiety. Each old girder weighed about 23 tons, and the only tackles available were of 10 and 5 tons capacity, *i.e.* marked by their makers "to lift 10 (or 5) tons." It is not apparent whether any factor of safety is allowed or any proper test applied when this marking is done. In this case two "10-ton" tackles on one end of one girder, that is carrying 11½ tons between them with the load correctly distributed by the device described below, showed distinct signs of failure by breakage of some of the teeth of the spur gear which drove them. The other tackles were driven by worm gear, and gave no trouble; this type seems a much safer and stronger one than that with a simple spur gear.

The tackles were attached to the girders by placing two short pieces of F.F. rail in an inverted position under, and at right angles to, the top boom. These were coach screwed to a wooden block jammed between the side plates of the top boom, a space of about 2 in. clear being left between the heads of the rails. Steel pins 2 in. diameter were inserted in holes drilled in the webs of the rail pieces, and the tackles hooked direct to these. When the two tackles at the end of one girder were of the same capacity, the pins were placed equidistant from the centre of the top boom; when of different capacities, the spacing of the pins was altered to divide the load in the right proportion.

After lifting was completed the girders were secured for travelling by simple rail slings in addition to the tackles. An engine was attached to the load and the whole pulled at a walking pace to the siding arranged for the reception of the girders, a distance of about a mile. Special preparations had to be made for this owing to the extreme width of the "train," and both lines of rail had to be blocked for the purpose. The

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girders were guyed forward and back to the trucks and travelled with surprisingly little oscillation. After the gang had got accustomed to the work, the time taken to lift, remove and lower a pair of girders in the siding was about five hours; but owing to traffic considerations not more than one span was ever done in a day.

The bridge was completed and opened for traffic by the Senior Government Inspector on 11th September, 1911, just two months having been taken in replacing the four old spans.

The work was carried out by the writer as subdivisional officer under the orders of Mr. E. A. C. Lister, the designer of the pile foundations, who was succeeded as Executive Engineer of the Lahore District by Mr. R. B. Addis when the work was well advanced, Colonel S. L. Craster, R.E., and Mr. A. Pakenham-Walsh being successively Superintending Engineers. The author's thanks are due to Colonel Craster for much valuable criticism in the preparation of this paper, and to Sir H. P. Burt, K.C.I.E., the Manager of the N.W. Railway, for permission to publish it and to utilize the official records from which some of the plates have been prepared.

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APPENDIX ON COSTS.

[1 Rupee = 1s. 4d.—15 Rupees = £1 sterling].

The final accounts of the work had not been completed at time of writing, but the following particulars may be of interest to officers serving in India :—

Reinforced Concrete Piles.

I. *Manufacture.*

(*a*). Materials—

		Per Pile. Rs.	
Cement ... 9 c. ft. at Rs. 1.75 per c. ft....		15.75	
Sand ... 13½ „ „ Rs.33 „ „ ...		3.5	
Stone ... 27 „ „ Rs.18 „ „ ...		4.85	
1½" dia. steel rods, 5.57 cwt. at 7/- cwt. ...		39.0	
¼" dia. wire, 97 cwt. at 12/- cwt.		11.6	
Forged shoe and C.I. struts, lump sum 15/- ...		15.0	
		89.7	
Moulding boxes		8.68	
		——	98.38

(*b*). Labour—

Making reinforcement and fitting up in box ...	8.5	
Concreting—30 men for ¼ day at -/8/- per day	3.75	
Removing boxes, loading, and unloading ...	6.69	
	——	18.94

II. *Driving.*

Contract rate with Lascar gang for driving only...	20	
Shifting machine from pier to pier	2.25	
Engine staff (1 driver, 1 fireman, 1 fitter) and 1 carpenter for wedges including stoppages for repairs of machine	5.67	
Cost of repairs to pile driver	10.0	
Coal, 10 cwt. per pile at Rs.14/- per ton ...	7.0	
	——	44.92
Total per pile		162.24

Or Rs.5.91 per l. ft.

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REINFORCED CONCRETE SLABS OVER PILE HEADS IN A PIER.

(*a*). Materials—

R.S. beams	... 64.3 cwt.		
Plates ...	... 1.0 ,,		
Rods ...	... 39.87 ,,		
Knees and rivets	4.5		
Total	... 109.67 cwt. at Rs.7.5 per cwt.	822.0	
Cement—97 c. ft. at Rs.1.75 per c. ft.	...	... 169.5	
Sand—184 c. ft. at Rs.33 ,, ,,	...	... 60.6	
½-in. stone—368 c. ft. at Rs.18 ,, ,,	...	... 66.2	
			1118.3
Labour for laying reinforcement, 109,67 cwt. at 3/-/- cwt.	... ...	... 328	

(*b*). Labour—

For concreting	30.3	
		358.3
[A gang of about 50—60 men—cost = Rs.8.25 per c. ft.]		
Total		1476.6

Or approx. Rs.4 per c. ft.

The abutment slabs had rather more material in them and worked out to a total of Rs.1654 each.

GIRDER ERECTION.

The contractor was lent all the plant, and had to find labour, fuel, and oil. He was paid Rs.20 per ton for finished work, including erection and removal of staging.

The pneumatic riveting plant was old and required much attention to keep it going. The cost of this worked out to Rs.3.45 per ton.

REMOVAL OF OLD GIRDERS.

The labour employed on removal of the old girders worked out to Rs.2.5 per ton.

Hire of trucks, engine power, etc., cost Rs.2.4 per ton.

This includes building the cribs and fitting up all the gear, but not dismantling it.

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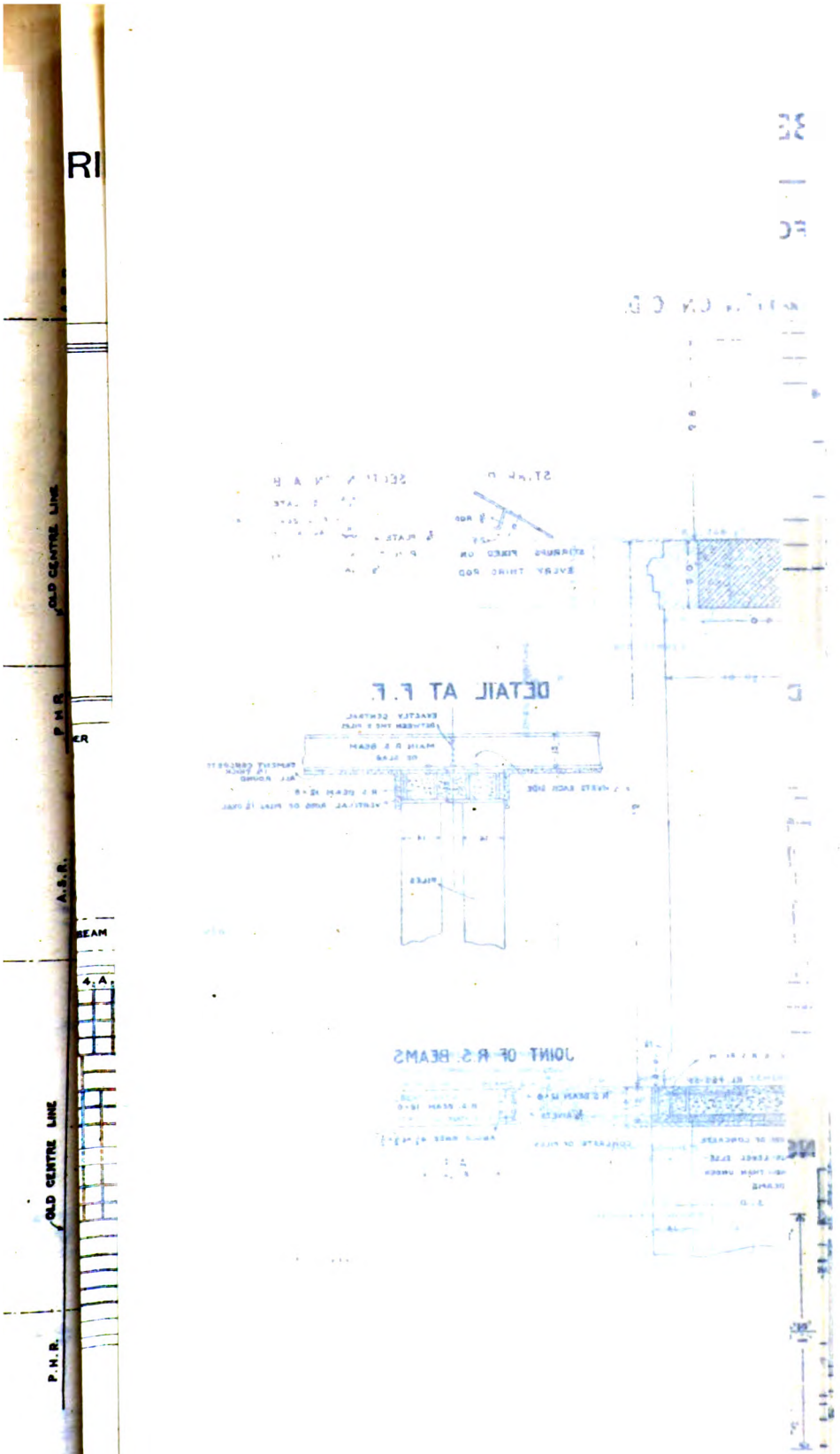

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(*a*).

(*b*).

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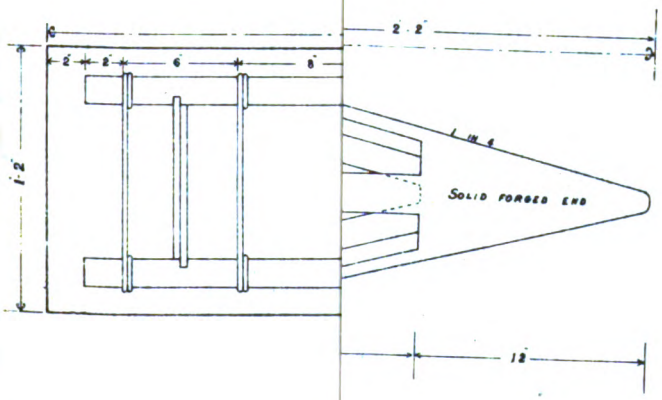

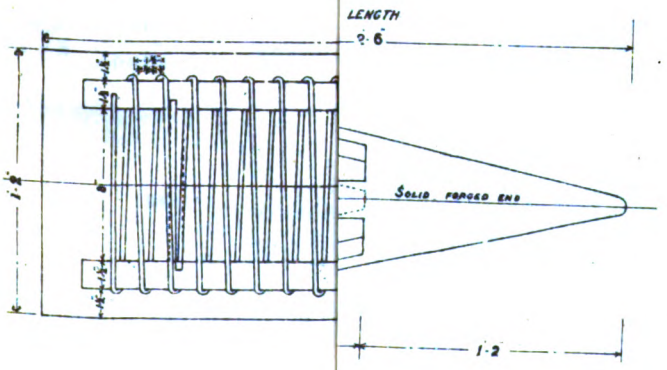

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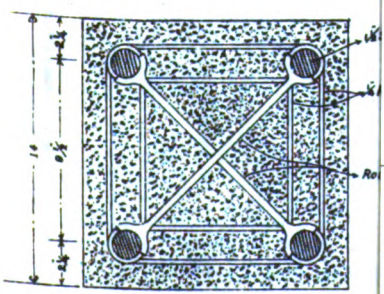

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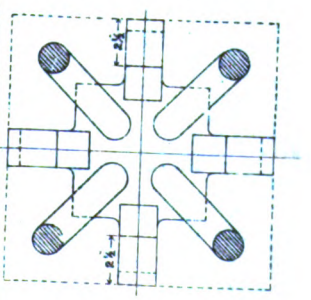

ON AB.

Concrete removed

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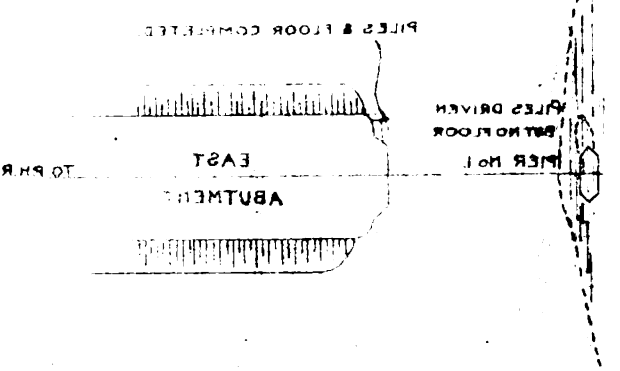

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SIEGE WARFARE.

By CAPT. E. ROGERS, R.E.

FORTRESS Warfare is a branch of the Military Art more affected than perhaps any other by the periodic ebb and flow of opinion. The influence of fortresses on the trend of military operations is as susceptible of proof, and as well supported by historical evidence, as any other of the main causes of defeat or victory, but yet it is undeniable that the subject has, from time to time, been strangely neglected by the leaders of military thought. Such a period of neglect occurred during the latter portion of the past century, and it was left for the twentieth century to establish the subject in a definite light, and return to it something of its bygone importance. France, Austria, and Germany in turn have begun to devote attention to it, and the result has been seen in the publication of a number of official textbooks, and in a still greater number of works by military writers of all classes. The revival of interest in this subject has been greatly stimulated by the events of the Russo-Japanese War of 1904–5, which, with the capture of Adrianople, provides the only examples of which the details are at present available of the attack of a fortress under modern conditions. German military opinion in particular is almost unanimous in asserting the future importance of the *rôle* of fortresses, as the following extract will show :—"The future will probably bring with it a closer connection between Field and Fortress Warfare ; a modern army must *henceforth* be always ready for the latter. Inadequate preparation in this subject, which appears constantly throughout military history, is likely in the future to have severer consequences than in the past."* The recently published works of another German writer which have received considerable attention in that country are of especial interest in view of the developments of the Balkan War. Colonel Frobenius,† in considering the influence of fortresses on the issue of a war, arrives at the conclusion that in the general case it will be essential for an army, carrying out an offensive campaign, to attack one of the frontier fortresses at the outset of the campaign. Since he bases his argument chiefly on the Franco-German War of 1870–71, he states as an axiom that the fortress to be attacked will be the frontier fortress "Sperrfestung" which lies astride of the line

* *Studien zur Kriegsgeschichte und Taktik. IV.*
† *Kriegsgeschichtliche Beispiele. XII.*

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of railway which is of most importance to the attacker. He goes on to show that, in order to bring the war to an end, it will frequently be insufficient to defeat the opponent's field armies; "the resistance of the enemy after the defeat of the field armies can only be broken by the capture of the important fortresses."* Therefrom Frobenius derives the necessity of no longer treating fortress warfare as a secondary operation, as Moltke did in his projects for the war of 1870–71, to be conducted by the landwehr and reserve formations; preparations for fortress warfare must exist in peace, be put into operation immediately on mobilization, and the operations carried on with the same energy and sacrifice as those of the field armies. To turn for a moment to the Balkan Campaign; here we find no frontier fortresses, but the definition given by Frobenius of the fortress to be attacked is clear; it is that used by Chesney, "fulfilling the necessary conditions attaching to important strategical points."† Adrianople, at the junction of the Maritza and its tributary streams, and astride the main line of railway crossing the Bulgarian frontier, fulfils these perfectly, and its influence, therefore, on the campaign has been considerable, and would in the hands of a commander of more offensive instincts than Shukri Pasha have been greater still.

How the awakening in Germany has come about can be gleaned from the introductory words of Major Scharr to his work on the engineer operations of a siege‡: "Interest in the subject of Fortresses and Fortress Warfare has been aroused during the past ten years by means of lectures, fortress war games, and staff rides, and by an extension of the Staff College course of Fortifications and Fortress Warfare."

In England, however, the interest in this particular direction is less marked. British military thought has, indeed, been revived by the lessons of the recent campaigns in South Africa and Manchuria, but it has been exercised in other directions. Leaders of military opinion have, not unnaturally, been preoccupied with our own army reorganization, which has made such strides during the past decade. In consequence this branch of training has not yet received the same amount of attention as in the countries already referred to.

It will probably be urged, by the opponents of fortress warfare, that the same standard of preparation is not required of us as for the Continental nations; and although such an argument might have been admissible in former times it is scarcely so under present conditions, and we should be prepared for the solution of all problems with which it may meet—"Neither the higher leaders nor their forces should be called upon to enter on Fortress Warfare, as on something unfamiliar to

* Frobenius. p. 24.
† Chesney. *On the Value of Fortresses.*
‡ Scharr. *Der Festungskrieg*, 1905

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them. It cannot be required of every general and staff officer to be both engineer and artilleryman, but they must be so far masters of the chief technical considerations as to be able in every case to make such a decision as will meet the circumstances of it."*

The general aspect of the case is, however, beyond the scope of these notes, in which it is proposed to consider the question from the standpoint of the technical troops, and it is proposed to briefly discuss the demands which would be made on these troops only when engaged in fortress warfare, to examine the provision made by foreign armies to meet these demands, and then to attempt to define our own particular requirements.

It will be well to commence by saying that the work of the engineers during a siege has increased to an even greater extent than in field operations. Up to the time of the Peninsular War, the artillery were considered capable of carrying out almost unaided the preparatory stages of the attack, viz. the paving the way for the infantry assault. That this was so in our own army is not surprising, there were no engineer troops. Up to about this date the duration of a siege in fact depended upon the amount of resistance which the fortress enceinte could offer to artillery fire, and once a practicable breach existed, it was generally held that a commander was justified in surrendering.†

For long after the Peninsula even, breaching tactics of the artillery were continued,‡ but with the gradual improvement in armament, and the consequent disappearance of stone revetment there came an increased demand for engineers, and the Siege of Sebastopol marked an era in the history of siege works.

The great importance of the siege artillery, however, remained, and the war of 1870–71 did nothing to shake the confidence in this arm. In the meantime the opinion grew, with the rapid improvement in armament, that resistance to a well-directed siege attack supplied with modern artillery would be in the future impossible. The experience of Port Arthur shows how unfounded was this belief, and has proved incontestably that the improvement in armament is as much, or more, to the advantage of the besieged than of the besieger,§ if only from the fact, that the increase in the perimeter of the fortress has denied to the artillery its old advantages of bringing enfilade fire upon the works, and has incontestably magnified the difficulties of the close attack. How overrated the power of the artillery has been can be judged from the history of the Siege of Port Arthur. Previous to the first general assault, the north-east front of the fortress was subjected to a terrific bombardment on 19th and

* *Studien über Kriegführung.* v. Freytag Lornighoven.
† Frobenius. *Kriegsgeschichtliche Beispiele.* p. 6.
‡ Jebb's *Siege Duties.* 1849.
§ Frobenius. p. 59.

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20th August, 1904, in which every available gun and howitzer took part—including field guns, a total of 258 pieces. The 37 Russian guns were unable to make any adequate reply, and at the end of the bombardment it seemed as though the permanent works must be a mass of ruins. But although 37 per cent.* of the Russian artillery was put out of action, chiefly owing to faulty siting of the batteries, the garrisons of the forts were unshaken, and the assault following the bombardment, after a continuous struggle night and day from the 21st to 24th August, ended in almost complete failure.

It remains therefore for the engineers to take up the old *rôle* of the artillery, viz. that of preparing a path for the final assault. By their unaided efforts they are incapable of doing this, and it is here that co-operation, the spirit of modern warfare, becomes of such vital importance. The ideal action of the engineers in co-operation with the infantry is well expressed by Colonel Frobenius. No longer are they the task masters in an unpleasant duty,† but "both arms would in my opinion more rapidly accomplish their task if they work together in comradeship. Let the sapper first work, and an infantryman with his rifle in his hand keep guard; then when the sapper after a time feels weary, let them change parts, the infantryman continue his work, and the sapper take over the duty of protection."‡ As the approach works get nearer to the fortress, the bulk of the work falls more and more heavily on the engineers, until, as was shown in the Siege of Port Arthur, the approaches in the immediate vicinity of the works can only be carried on by that arm, and then under the greatest difficulty. The work of preparing the assault will, to a great extent, be entirely an engineer matter. Major Scharr gives the following list of duties which the artillery is unfitted to accomplish against a modern fortress§ :—

(1). The removal of protected obstacles.
(2). The destruction of ground mines.
(3). Destruction of the flanking defence of the ditch.
(4). Blowing in the counterscarp.
(5). Complete destruction of the armoured turrets.

To consider a single one of these duties, viz. the destruction of the flanking defences of the ditch. The experience at Port Arthur is fresh in our minds. Here the approach to the ditch was not seriously contested. The Russians up to October had made no attempt at countermining, and the Japanese established themselves above the counterscarp in each of the three main works of the

* Frobenius. p. 70.
† *Sevastopol*. Jones & Elphinstone.
‡ Frobenius. p. 132.
§ Scharr. *Festungskrieg*. p. 85.

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Eastern front without having recourse to mining. From this time, however, until the defences of the ditches were finally destroyed, over a month elapsed, during which time constant warfare of a most desperate character was carried on in the ditches and the galleries under the counterscarp.* How the difficulties of the Japanese engineers would have been increased had the Russian works been provided with such a network of subterranean galleries as that in front of the Flagstaff Bastion at Sevastopol,† one can only imagine.

It is evident that none of the engineer operations above referred to can be carried out without loss, and the expenditure in *personnel* in this arm is, in fact, out of all proportion to that sustained by other arms, during the preparatory phases of the attack. Before Port Arthur the casualties of the engineers engaged in the approaches alone amounted to no less than half of those of the infantry engaged in the same work, and the Japanese, in addition to forming five fresh units, were compelled to withdraw every trained miner from the field army units engaged in Manchuria, thereby depriving them of the possibilities of making use of mining operations in the field on occasions such as during the Battle of the Shaho, when it would have been of the greatest value to them. At the end of November, 1904, out of a strength of 800 engineers attached to the IXth Japanese Division, only 60 were fit for service, and all the engineer officers had been killed or wounded.‡

Without entering further into the question it will be clear that special provision for an increase in *personnel* of engineers is essential to the conduct of a siege, and it will be interesting to examine briefly how this special provision is made in other armies.

In general the method adopted is (1) the formation of special combatant units in addition to the engineer field units attached to divisions, corps, and armies, and (2) the formation of other special units whose duties are of a secondary nature, and concerned with the preparation, storage, and issue of the technical material. The latter are known as Siege Trains or Siege Park Companies.

In the Russian Army the special units are formed from the specialist miner sections attached to both field and fortress companies. These sections, as their name imply, receive more advanced instruction in siege warfare than the remainder of the units, and are assembled periodically, brigaded with those of neighbouring units, whether field or fortress, and take part in combined fortress operations. The training of miner sections of fortress companies, however, is carried out on purely defensive lines, "their work should be directed to the conditions of defensive warfare only, . . . and

* *Port Arthur.* Schwartz & Romanoffsky.
† *Sevastopol. Opérations du Génie.* Niel.
‡ *Port Arthur.* de Grandprey.

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should always be carried out in the direction of the opponents." The Siege Park Companies exist only as cadres during peace, and are organized on mobilization. Each section of a siege park contains sufficient tools and stores for the siege of an ordinary fortress.

The German special engineer units are organized on a regimental basis, each of two to three battalions. They are formed by expansion on mobilization from certain battalions trained in siege duties. To each regiment is attached a siege train.

The French preparations are somewhat similar to the Russian, but siege training is, consonant with French tradition, assigned a much higher importance. The Siege Regulations foresee the necessity of reinforcing the field engineer units even during the attack on the covering position.* The French siege units are the *équipages de siège*, and are formed from the ordinary *sapeurs-mineurs* companies. The first year's instruction of a sapper recruit includes a considerably greater proportion of siege works than in other armies, and a certain proportion qualify as first-class miners and as such are distinguished by a special badge. The training of the miners is carried out annually at a special siege camp. The *personnel* of the siege train is formed on mobilization, but the material is stored in peace time.

Turning to our own army we find that our divisional organization is supplied with an engineer *personnel*, and that the necessity of further organization for siege purposes is recognized. It is of interest to consider what this provision would probably need to be so as to meet our own special needs, and for this purpose it appears reasonable to assume that each of the special units required for siege purposes should be of such a nature as to supply the whole of the staff and *personnel* required to undertake a certain definite task. Such a task might well be the attack of a defined sector, *i.e.* one of the permanent *points d'appui* of the perimeter together with the subsidiary works in advance and on either side of it, which together go to make up one of the self-contained organizations of the defence. As all these works will be mutually self-supporting it follows that the attack delivered against the whole group must be co-ordinated, and as it would usually be entrusted to a definite infantry unit, so also must the special engineer troops be contained under a single directive engineer staff. This is in fact the principle adopted in the French army.† Each of the *équipages de siège* previously referred to is composed of eight *sapeur-mineur* companies, formed for convenience in administration in two battalions, but grouped under one directing officer with his staff. The total strength of the unit is therefore about 2,000. The German organization is similar; if we take a siege regiment on the lower establishment it would be about 1,500 strong,

* *Instruction sur le service du génie dans la guerre du siège.* p. 46.
† *Instruction générale du* 30 *Juillet*, 1909, *sur la guerre de siège.* p. 30.

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and would probably be allotted a similar task—the disparity is due perhaps to the fact that the Germans look to their infantry for a greater measure of co-operation in the close attack than do the French.

We can, however, arrive at an estimate of the numbers required from an independent calculation, based on the work to be done. For the sake of this calculation we will consider a single stage of the close attack—the mining operations—here we find we have a certain amount of evidence to go upon. It is of the utmost importance, once the mining operations have been commenced—and it will often be impossible to dispense with them—that they should be carried on without pause. Such a delay as occurred in the French operations before the Flagstaff Bastion at Sevastopol, when it was necessary to withdraw the whole of the mining engineers to the Malakoff,* would be fatal to the success of the attack. The whole chances of the attack depend on the defender's miners being allowed no time to repair the damage caused to their galleries by the overcharged attacking mines, on their attention being constantly absorbed by means of false galleries, by shafts hastily sunk at a distance from the main galleries, by charges fired from bored mines, and in fact by their being prevented by every artifice of an energetic attack, from forming new galleries in the line of the main advance. At Port Arthur it was found necessary not only to construct underground approaches against the main works, but also against the intervals. It is not difficult to calculate the number of men required for a single gallery or line of galleries under peace conditions. But under war conditions it is important to make reliefs as short as possible, and it is certain that to drive a line of six galleries no less than 250 engineers are required, in addition to assistance from infantry parties in removing earth, etc. Against an active defence it will probably be necessary to allow a minimum of ten galleries against the main work, and if we allow an equal number against the interval works we reach a total of 800 men for the mining operations alone. But the effective numbers of the siege engineers will have been diminished by at least one-half during the preceding phases of the close attack, and we therefore arrive at a unit some 1,600 strong, a number which is intermediate between the strength of the French and German units.

It is evident that such a number is out of all proportion to the normal allotment of engineers for the attack of field defences of similar extent, especially when it is borne in mind that these numbers must be regarded as over and above the strength of the field units. The latter will be kept busy supplying the immediate needs of their own divisions, and cannot be considered as available for the close attack.

* *Sevastopol.* Niel.

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How many of these siege units are needed, depends upon the task to be accomplished. It is generally accepted that the zone of the close attack must embrace not less than two of the permanent works. But, however that may be, no smaller unit can be formed, as the task to be performed by it cannot be further subdivided. Moreover, no such important task as the siege of a great fortress has ever been carried out by mere numbers, however great. Nor will a more thorough training of the technical arm alone suffice, without the co-operation in practice of the other arms. How this ideal training is to be realized is suggested in the following words in a work already referred to in the course of these notes :—"Let the Siege Manœuvres be carried out not as up to the present, but at the great training grounds of the Infantry and Artillery, let there be constructed there a permanent skeleton of strong Fortress works, let the different arms carry out their own technical work in attack as well as in defence under specified conditions, and as far as possible let the Artillery bombard the works, and the Engineers carry out actual demolitions."

The writer adds "We must not be deterred either by the high cost of these operations, or by the danger to *matériel* or *personnel* under service conditions. All this is as nothing compared with the danger of our being found wanting at the decisive moment."*

* *Festungskrieg*. Scharr. p. 87.

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BELL BUNDS.

By MAJOR H. E. C. COWIE, D.S.O., R.E.

IN Capt. F. C. Molesworth's "Training Works in the Swat River' which appeared in the February number, 1913, of the *R.E. Journal*, allusion is made on page 71 to "Bell" bunds. As many officers may not be acquainted with the meaning of a Bell bund, the following notes may be found useful.

The Bell bund as applied to sandy river beds is thoroughly elucidated in Technical Section Publication No. 153 of the Indian Public Works Department, by F. J. E. Spring, price 10s. 6d. In these notes some of the principles will be indicated, and it is hoped that officers may be induced to criticize and give further remarks of their experiences.

Nearly all unstable waterways in India have an area over which the water channels meander; this area is known in India as the "kadir," and is bounded by more or less permanent banks which the water channels seldom transgress (*Fig.* 1).

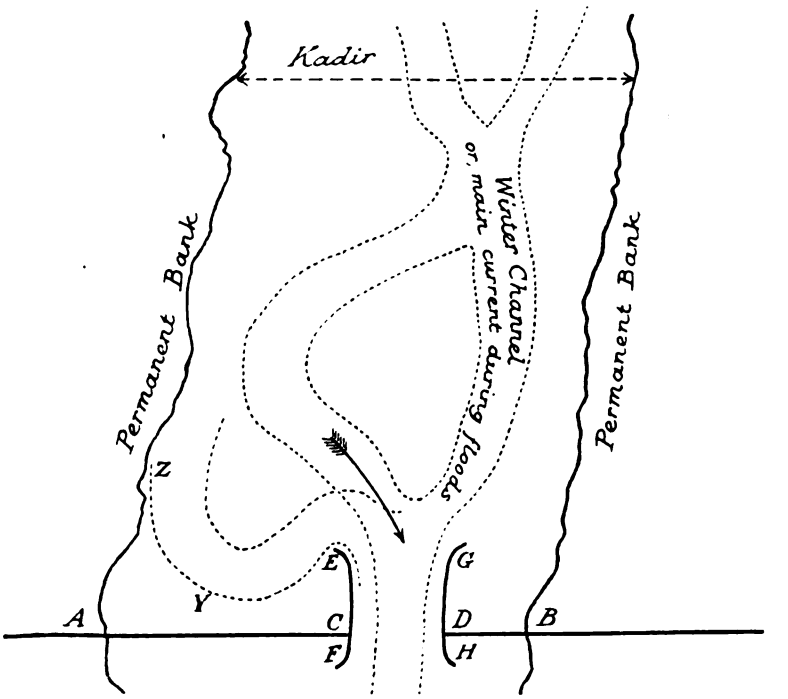

FIG. 1.

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This kadir may be anything up to 10 miles wide, as for instance the kadir of the Lower Ganges from Monghyr to the sea, and in flood season is nearly covered with water, but in the winter, or low water season, water will be confined to limited channels as indicated by the dotted lines. The main current during floods, or the water channels during the winter, may take up any position between the permanent banks, and will seldom be the same in two consecutive years. The position of the main currents during floods will not necessarily be the position of the ensuing winter channels.

But suppose a bridge is to be built across AB. It is beyond the bounds of practicability to make a bridge of length AB, so the waterway must be confined. The roadway must run on made-up banks, AC, DB and the bridge between C and D, the location and width being chosen by common sense and certain rules, which are laid down at length in No. 153. It is evident that if permanent bunds EF, GH can be made and AC, DB protected against any possible attack, the waterway will become stable between C and D, and the bridge will be safe.

First of all what will protect AC against attack? In the main, it is the length CE, for if CE is made long enough the water must curl back to flow between CD before it can reach AC. Now the sharpest bend that a river can take can be ascertained from surveys and observation. It depends on the velocity of the water, on the nature of the soil of the kadir whether sand or shingle or so on (*vide* No. 153), but a survey of 20 miles of the river will show what the sharpest curve actually is for the river at the locality in question.

Having determined the sharpest radius that the river takes, CE must be made long enough to ensure that the water will bend back past the point E before it can touch AC, as indicated by the dotted line ZYE, where $\frac{ZE}{2}$ is the smallest known radius that the river ever takes in the vicinity.

Similarly for DG. The lengths CF, DH are determined by similar reasoning, that is to say, the water after passing F and H must never be able by means of swirls and eddies to bend back and attack AC, DB. Swirls and eddies should not be set up anywhere, and if they are observed, the design is at fault, that is, CE is not long enough or the curves of the bunds at E and G are too sharp. It is usual to make both bunds EF and GH exactly similar, as the more symmetrical these bunds are, the less likelihood of swirls. Other things being equal, CE and DG are each made equal to CD.

The width CD to take the water, is determined from observations of the maximum discharge in flood season, the maximum velocity, and the maximum scour anywhere in the vicinity. These considerations for rivers with sandy beds are fully given in No. 153, and would

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probably be sufficient guide in cases of rivers with beds of a different nature. Roughly speaking the width CD must be such that the flood discharge can be passed without excessive scour, which means excessive velocity, scours and velocities being ascertained from surveys and observations of the river over a distance of some miles above and below the bridge site.

All that now remains is to design the bunds EF, GH so as to be permanent. Permanency depends on two considerations :—

(1). That the surfaces in contact with the water are inerodible. This can be secured in different ways, but the most usual and generally the cheapest is to protect the surface of the bund with blocks of stone or other heavy material that does not weather, the size of each block being sufficient to prevent displacement by wave action or by the current. In broad rivers wave action is of course far more serious than the action of the current. The ordinary brick is said to be sufficient protection against simple velocities up to 13 ft. per second, but in waterways over $\frac{1}{4}$ mile wide, wave action may necessitate the use of blocks up to 80 lbs. each. The protection must also be thick enough to prevent any action of waves or current entering between the blocks and disturbing the soil of which the bund is made.

(2). That the protection mentioned in (1) is carried below any possible depth of undermining action of scour. The difficulty is to carry this protection down to the proper depth and to ensure the completed surface being smooth and even. For any unevenness or hollows induce eddies and whirls, which cause scour far deeper than the scour caused by the velocity simple of the current.

Now it is a matter of experience that stone laid as LM in *Fig.* 2 will in course of time gradually assume the position LR, if the edge KR is of a sandy nature and scour takes place against KR, this edge gradually retreating towards L as the stone from M falls into position R. *Fig.* 2 is a section and *Fig.* 3 the plan of a Bell bund designed to carry out the above considerations.

In *Fig.* 2 the following points must be observed :—

(*a*). The stone in KL must be thick and heavy enough to resist current and wave action. In the part LR, that is the part below low water, the stone has to resist current action only, but as the stone has to be laid as LM, the heavier each block of stone is the better, as then each block is more likely to fall direct into its correct position in LR when the scour KR takes place. The blocks of stone should be angular, as being less likely to roll and when in final position LR they will jamb and be less likely to be displaced. The thickness T, is generally from 2 ft. to 4 ft. If stone is to be hand pitched, stone blocks between 60 lbs. and 160 lbs. is a convenient size, for these can be handled by one man.

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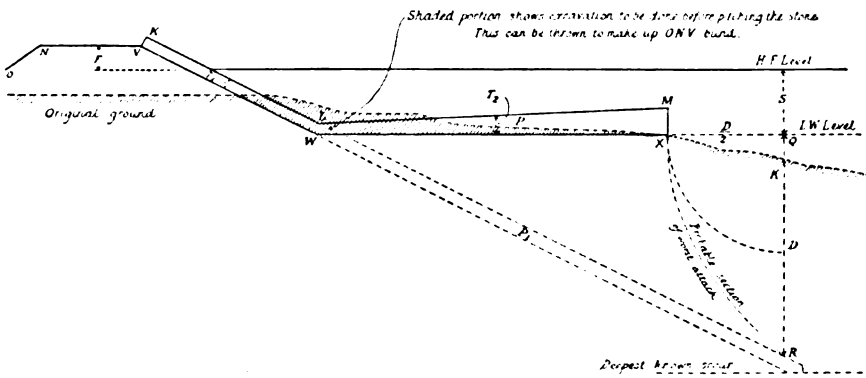
Shaded portion shows excavation to be done before placing the stone
This can be thrown to make up ONV bund.
H.F.Level
I.W.Level
Original ground
Deepest known scour

MR. SPRING'S RULES.

F = freeboard.
S = rise of flood.
D = deepest known scour = QR.
T_1 = thickness of slope stone.
Area of slope stone = 2·25 T_1 (S + F).
Apron = LM = 1·50 D.
LW = T_1.
MX = 2·76 T_1.
T_2 = 1·88 T_1 = mean thickness of apron stone.
Slope VW = 2 to 1 = desired inclination of WR.
Area of apron stone = 2·82 D T_1.
KVWXML = original position of stone protection.
WR = desired position of stone protection.

FIG. 2.

(*b*). The thickness of stone in LM must be greater than in LK, because, when falling into the LR position under water, it is not possible to ensure that each stone will fall properly into its correct place, and so a margin must be allowed so as to make certain that there is a complete protective covering between L and R of from 2 ft. to 4 ft. thick.

A good rule is to make the average of T_2, 1½ times T_1 and to put more stone towards M as the distance the stones have to fall from M to R is greater than from P to P_1.

(*c*). The width NV is usually made wide enough to take a railway track, so that fresh stone can quickly be railed to site, should any of the stone in LR get out of place. For the same reason a reserve of stone is kept near at hand or even on NV.

(*d*). The slope VWR is usually 2 to 1, which is the slope found by experience that stone takes up when falling from such positions as LM to LR.

(*e*). LM, usually called the apron, must be so wide that when the stone takes its final position (it may be after some years) the point R will reach well down to the depth of maximum scour. (This maximum scour is found as described above from surveys and observations of the deepest pools and reaches of the river. In the lower Ganges

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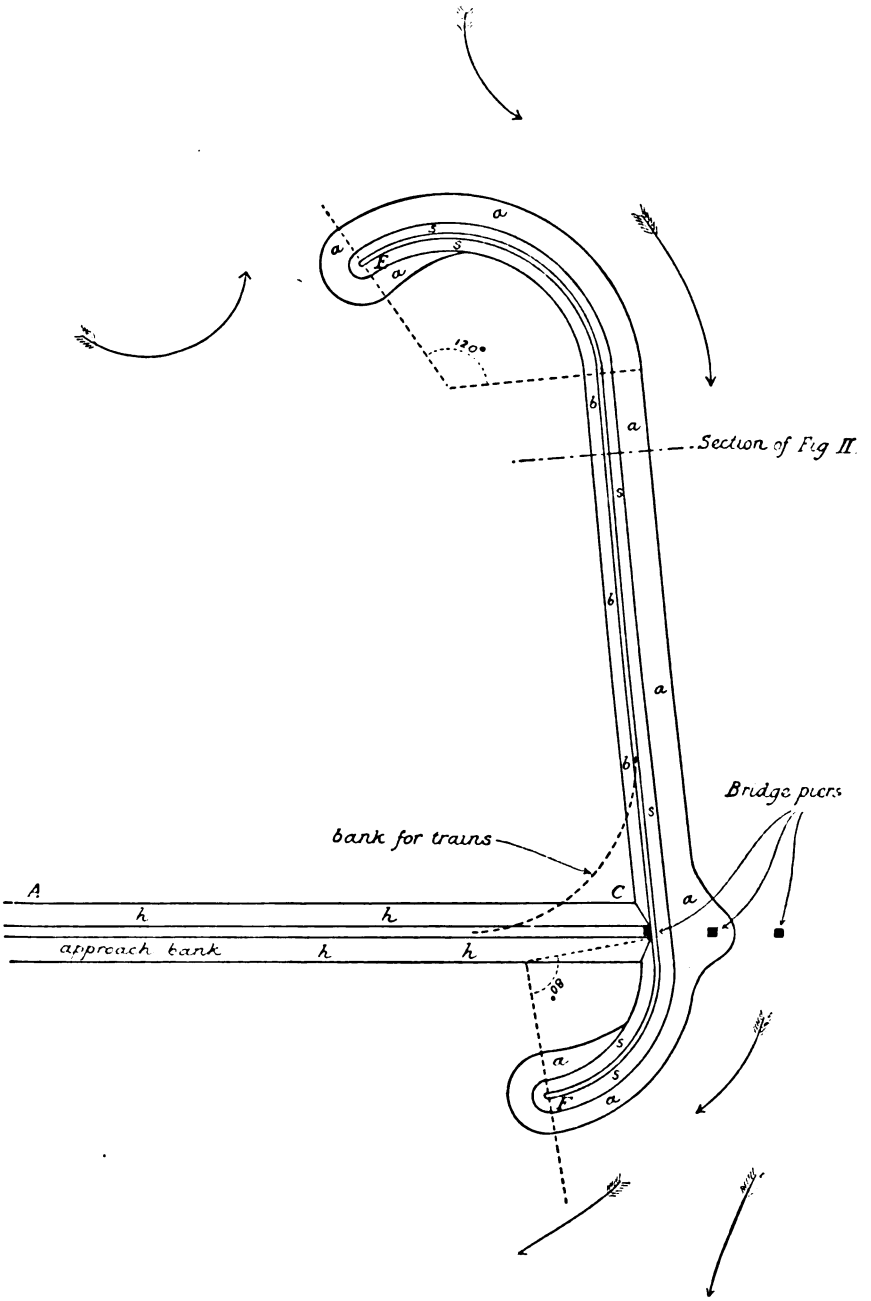

aaa = apron.
sss = slope stone.

The area AEC will in course of years silt up. If there is water here the slope stone must be continued to *bbb* and on *hh* to protect against wave action. This area AEC is usually strengthened by planting shrubs, trees, etc.

The two bunds are sometimes parallel, sometimes slightly contracted or expanded between E and G (*Fig.* 1).

FIG. 3.

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Bridge now being built at Sara, the maximum depth of possible scour has been fixed as 100 ft.).

(*f*). The stone protection LM should be laid at times of low water, so that the stone does not have to fall further than can be avoided. The bund ONVW and protection KLM should be laid during one low water season, as it is important to have the slope KLR as even as possible along the whole length of the bund. If only half the bund is made in one season, it may be impossible to get the bund straight without enormous excavation due to the fact that before the next low water season enormous quantities of sand may be silted up against the unfinished portion, or scour may occur in that portion, making deep water where the bund should be built. It must also be remembered that a bund is not completely safe until finished.

(*g*). The top of the stone at K must be well above any wave action or wash.

As regards *Fig.* 3

(*a*). There will evidently be likelihood of a rush of water round the ends E, F, so that the protection and apron must be carried round as shown.

(*b*). The ends E, F, are generally curved back as shown, the radius being such

(1). That a railway track can go round them.

(2). That water will cling to the curve without forming whirls. It is found that water flowing at 8 ft. to 10 ft. per second will cling to hand-packed stone surfaces of 600 ft. to 800 ft. radius.

(*c*). Extra stone must be given to the apron round the curved ends E, F, because when falling to its final position, R, *Fig.* 2, it will have to cover an increased surface.

The ideas and principles stated in these notes are mainly extracted from Publication No. 153, which deals with rivers in sandy channels, but they can probably be applied to many cases of training works coming under the charge of officers of the Corps, and they should be carefully studied in No. 153 itself, and modified for special conditions. A little knowledge is a dangerous thing.

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LEGAL KNOWLEDGE ESSENTIAL TO ENGINEERS.

(*Lecture by* MAJOR W. A. J. O'MEARA, C.M.G., LATE R.E., BARRISTER-AT-LAW, *to Students, Faraday House, 5th March*, 1913).

IT is hoped that the title of this lecture will not have unduly alarmed you. Pray do not run away with the idea that I propose to advocate the view to-day that every engineer should attempt to become his own lawyer; nothing is further from my mind, as I hope to show you later. I neither think that this would be possible, nor do I recommend that, as a general rule, an engineer should attempt to combine the double *rôle*. Indeed, were such a proposition to be put forward, it would stand self-condemned as being opposed to one of the essential principles of economics, which is continually prompting specialization as the readiest means of attaining the highest degree of efficiency.

You may quite rightly enquire why it is then that the particular title given to this lecture has been adopted by me. The theory that every man is assumed to have a knowledge of the laws of the land is probably present in your minds, and you have no doubt learnt, that as in so many other instances in this world, so in this, the requirements of theory are not fulfilled in practice. You may, therefore, well wonder whether there is any particular reason why an attempt should be made to put an additional burden on the poor engineer who has already certainly a sufficiently heavy intellectual load to carry. I should indeed be extremely optimistic, if I could think for a moment, that my opinion alone that an engineer stands in perhaps a somewhat different position to that occupied by men in the majority of other callings, unconnected with the law, could prove a sufficiently convincing argument to support the view expressed in the title of this lecture. I do not, however, propose to adopt any course so dangerous as to ask you to accept my own views unsupported by weightier arguments. It is always well to be frank, and I propose to confess to you that the idea conveyed by the title of this lecture has really been accepted by me owing to the views expressed by Lord Fletcher Moulton, one of the greatest of our Law Lords, in his Introduction to the valuable work by Mr. L. W. J. Costello, entitled *The Law Relating to Engineering*. The following are the words of his Lordship:—"The profession of an engineer involves much more than mere engineering knowledge or even

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executive skill. In a large proportion of the matters in which he is consulted he has the responsibility of giving advice, and that advice often relates to acts in which the rights of third parties are directly or indirectly involved. This consideration alone would make it desirable that he should have a sound knowledge of such branches of the law as bear upon the questions he has to resolve. But his need of clear legal conceptions does not depend on this alone. He has not only to administer, but often to frame, contracts of a character which beyond doubt, renders them the most complicated of any that have to be interpreted and pronounced upon by our Courts, and their nature is such that he can only pass on the responsibility to professional lawyers to a small extent. The rest deals with matters so technical that it must remain in his hands."

The above extract expresses with great cogency the peculiar position which an engineer occupies in our industrial organization to-day, and at the same time indicates in some measure how his position differs from that of men engaged in many other callings. It must be borne in mind also, that professional men occupy a peculiar position in the eyes of the law, and to emphasize this latter point I cannot do better than to call your attention to the following extract from Hudson on Building Contracts:—"An engineer must be competent to do what he professes, or take the legal consequences of recovering nothing and being sued for negligence." And by implication an engineer professes to be acquainted with the provision of general and local statutes, by-laws and regulations affecting the works he is engaged upon, and he also professes to have a general knowledge of the ordinary rights of the public.

The object of this lecture, as I have indicated already, is not to impart knowledge which will enable you to become your own lawyer but rather to indicate, very generally, to you what kind of legal knowledge is essential to the engineer, in order to enable him to form a correct judgment as to the situations in which it is desirable that he should seek legal advice, and thus protect himself, as well as his client.

The old adage that "A stitch in time saves nine," is as true in relation to matters affecting legal rights and obligations as in all other departments of life. Money wisely spent on competent legal advice, at the inception of important projects, and in cases in which the question of the infringement of legal rights arise, will often prove a profitable investment and save the expenditure of a larger sum in an attempt to correct an improvident or a careless act.

You are probably all aware that the infractions of law are, for the purposes of justice, divided into two main classes; namely those relating to public and those relating to private injuries. The former class of offences are commonly called crimes, and consist of offences

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subversive of law and order; it is not within the scope of this lecture to deal with the offences falling in this category.

Private or civil injuries consist of violations or deprivations of the legal rights of individuals, and it is a knowledge of the principles which govern the rights and obligations in certain classes of cases falling under this category that are of peculiar importance to engineers. Civil injuries are subdivided into two classes, namely, injuries *ex contractu* or those arising out of the violation of duties undertaken by contract, and injuries *ex delicto* (commonly spoken of as "torts") or those springing from the violation of duties imposed by law, to the observance or performance of which every individual in the community is entitled as against the world at large. There is no well-defined border line between these two subdivisions, but they overlap to some extent.

The civil law, in its broadest sense, is based upon a very few elementary principles of justice, fairness, and equity which may be as easily learnt by a layman as by a lawyer. It is the application of these principles to concrete cases, which provides the necessity for the special study which those desiring to follow the calling of a lawyer are obliged to undertake. At one time it was a knowledge of Contract Law alone which was a fundamental necessity to engineers; but owing to the changes which have taken place in the nature of engineering enterprises, engineers must nowadays give increasing attention to matters connected with the general rights of the public, since neglect of them may involve them and their clients in an action for a tort.

Law of Torts Important to Engineers.

It is matters more particularly connected with torts of the following kinds which affect the engineer in his calling in a special degree, namely:—

(i.) Injuries arising peculiarly from acts of negligence,
(ii.) Injuries caused by breach of duty to prevent damage from dangerous things,
(iii.) Injuries or damage caused under circumstances held at law to constitute a nuisance, and
(iv.) Injuries to workmen.

(i.). *Injuries arising Peculiarly from Acts of Negligence.*—Actionable negligence has been defined as the breach of a duty, either

(i.) To do something which a reasonable man guided upon those considerations which ordinarily regulate the conduct of human affairs would do, or
(ii.) To abstain from doing something which a prudent and reasonable man would not do, whereby loss is caused.

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In considering cases falling under this category, the real point to be decided is whether the negligence of the defendant was actually the effective cause of the damage. It sometimes happens that although the defendant was negligent, the real effective cause of the damage was either the negligence of the plaintiff or the negligence of a third person. The former is an aspect of contributory negligence and the rule is, briefly, that where the damage would not have happened had the plaintiff himself used ordinary care, the plaintiff cannot recover from the defendant. When the immediate cause of the damage is the interference of a third party, it does not necessarily follow that the defendant is not liable. In every case, it is a question of fact whether the negligence of the defendant was an effective cause of the damage or merely a remote cause. In the former case he is liable and in the latter not. It should be borne in mind that in an action of negligence it is a good defence to show that the plaintiff, with full knowledge and appreciation of the risk of danger arising from the defendant's negligence, voluntarily accepted the risk and exposed himself to the danger.

The onus of proving negligence lies on the plaintiff; and that of proving contributory negligence on the defendant. But where a thing is under the control of the defendant or his agents, and the accident is such as, in the ordinary course of events, does not happen to those having the control of such things and using proper care, the accident itself affords *prima-facie* evidence of negligence. Cases of this kind are of much importance to an engineer. To illustrate what is meant, let us consider for a moment one or two cases which have been decided in the Courts :—A well-known case is one where a man was walking in a public street, and as he was passing by a warehouse a barrel of flour fell upon him from a window of the defendant's house, inflicting injuries to his person. The Court held in this case that there was sufficient *prima-facie* evidence of negligence to cast on the defendant the onus of proving that the accident was not attributable to his want of care—the theory naturally being that barrels do not as a rule fall out of windows in the absence of negligence. In another case, where a railway train was thrown off the line whereby the plaintiff (a passenger) was injured, under circumstances in which the engine, the coaches and the permanent way all belonged to the same company, the Court again held that there was a *prima-facie* case of negligence, as trains do not run off the line unless there is some defect in the track, or the train, or the running of the train. In each case the nature of the accident must be carefully enquired into, and even then it may not be possible for the Judges entirely to agree as to the deductions to be drawn from the evidence. This is proved by a case which recently was carried to the Court of Appeal. The facts of the case are simple : a passenger on an un-

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covered tramway car propelled by overhead electric traction sustained damages by the head of the trolley-boom falling on him. Evidence was given to show that the system of electric traction adopted by the defendant company was the best and most widely used, and that the apparatus on the particular car was in perfect order, and further that there had been no negligence on the part of the defendant's servants. The case in question was originally tried in the King's Bench Division with a jury, and the jury returned a general verdict for the plaintiff, with £150 damages. The learned Judge had intimated to the jury that, if they should find for the plaintiff on the ground of negligence, he would ask them to specify the negligence. The jury were unable to suggest what additional precautions could have been taken in this particular case than those disclosed in the evidence; and in consequence the Judge found for the defendants. The plaintiff in this case accordingly appealed. In the Court of Appeal the majority of the Judges (two to one) after listening to the arguments of Counsel in this cause held that, as to the standard of care required in the case of a carrier of passengers, it is sufficient that the carrier should adopt the best known apparatus, keep it in perfect order, and further that the servants employed should work it without negligence on their part. If these conditions are fulfilled the defendant, in the view of the Court, ought not to be held responsible for the consequences of an extremely rare and obscure accident which cannot in a business sense be prevented by any known means.

The dissentient Judge drew the conclusion from the evidence submitted that the truth appeared to be that the accident was so rare that defendants had not troubled to try and guard against it, but had taken the chance. He was of opinion that the verdict referred to, was one which the jury were entitled to give on the evidence. The real issue was whether the defendants had proved affirmatively that they had done everything that skill and care could provide. The above extracts from a case decided only in December last will help to explain how necessary it is for engineers to have some conception of the legal view as to their responsibilities in such matters.

The kinds of cases in which the allegation of negligence, express or implied, may arise are innumerable; it is naturally impossible to deal with so exhaustive a subject in a single lecture, but it is hoped that sufficient has been said on the subject to prove of some real value to you.

(ii.). *Injuries caused by Breach of Duty to Prevent Damage from Dangerous Things.*—It is a rule of law that where a person for his own purposes brings on to his land and collects and keeps there anything likely to do mischief if it escapes, he must keep that thing at

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his peril; and, if he does not do so, he is *prima facie* liable for all the damage which may result as the natural consequence of the escape. In cases of this kind a person may naturally excuse himself by showing:—

(i.) That the escape was the consequence of the act of God, or
(ii.) That the escape was caused by the plaintiff's default.

But he cannot as a general rule put forward the excuse that the escape was due to the act of a stranger.

A famous case which well illustrates the principle involved is that in which the plaintiff was the lessee of mines and the defendant a mill owner. The latter had a reservoir constructed on his own property by competent persons, so that there was no negligence on his part. Owing to the existence of disused vertical shafts which had been filled up, and of old workings under the site of the reservoir, the plaintiff's mine was flooded. The plaintiff, in consequence, brought an action for damages against the defendant and won it. The gist of the action in this case was the collecting of the water and not keeping it from escaping, and whether this escape arose from negligence or as the result of a latent and undiscovered defect in the engineering works, was quite immaterial so far as the responsibility of the defendant in the matter was concerned.

The same rule has been applied to the escape of electricity, and, with modifications, is the foundation of the liability for damage done by fire. It should be observed that the liability in cases of this kind does not depend on negligence; the principle of the rule is as explained, namely, that a person who brings a thing, likely to cause damage by its escape, on to his land for his own purposes, is responsible for all the consequences if an escape should actually occur, in spite of the care he may have exercised to provide against its escape.

(iii.). *Injuries or Damage caused under Circumstances held at Law to constitute a Nuisance.*—The injuries under this head may arise either from a public or a private nuisance; the line of division between them is in some cases rather fine. A public nuisance has been defined as some unlawful act, or omission to discharge some legal duty, which act or omission endangers the lives, safety, health or comfort of the public, or by which the public are obstructed in the exercise of some common right. The proper remedy in such cases is either criminal proceedings or an information by the Attorney-General on the part of the public. A private person can only bring an action in respect of a public nuisance where he has personally suffered some substantial particular damage beyond that suffered by the public. Any obstruction of the highway, or anything rendering the use of a highway unsafe or incommodious to the public, as for

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instance the digging of trenches thereon or immediately adjoining thereto, the erection of hoarding on a highway, etc., constitutes a public nuisance.

A private nuisance has been defined as some unauthorized user of a man's own property causing damage to the property of another, or some unauthorized interference with the property of another causing damage.

Acts done by a person on his own land which materially interfere with the ordinary physical comfort of his neighbours also constitute a nuisance, and give rise to a cause of action. The maxim of the law in such cases is :—" So enjoy your own rights as not to injure those of another."

The destruction of shrubs from the fumes given off from the chimney of a smelting works ; smoke, unaccompanied with noise or with noxious vapour ; noise alone ; vibrations caused by machinery in motion, may severally constitute a nuisance. Further, any unjustifiable interference with an easement or other servitude is usually classed with nuisances. The easements known to our law are numerous, of which the most familiar are :—

(*a*) Rights to free access of light and air,
(*b*) Rights of support for buildings,
(*c*) Rights of support for land,
(*d*) Rights of way, and
(*e*) Rights to the use of water.

Questions affecting one or other of these rights will often be met with by you in your practice as an engineer, so that it is always well to be on the look-out for their existence.

It is well to remember that it is considered proof of ignorance and unskilfulness not to act in accordance with the rules of a profession. And the effect of this is to render an engineer liable for any damage resulting to his employer from any neglect to employ the usual and proper means for examining the site of a work, etc., and of ascertaining whether there are rights of way, light, support, or other easements before he makes his plans.

(iv.). *Injuries to Workmen.*—Generally a master is liable for the negligence of his servant for acts committed in the course of his employment. However, the liability of a master to his servant for an injury arising from the negligence of a fellow-servant is on a different footing to his liability for an injury to a stranger or third party.

This results from the doctrine of Common Employment founded on the idea that the servant takes all the risks incident to his employment as part of the contract of service. The Legislature has in

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recent years created exceptions to the old rule of the Common Law, for :—

(i.) By the Employer's Liability Act, 1880, a remedy by action for damages has been provided in certain specific cases for servants who are injured by the negligence of their fellow-servants in the course of their employment, and

(ii.) By the Workmen's Compensation Act of 1906—which does not, by the way, repeal the Employers' Liability Act—all servants to whom it applies are given a statutory right to be compensated for accidents suffered by them "in the course of and arising out" of their employments, whether such accidents are caused by the negligence of a fellow-servant or not.

Under the doctrine of Common Employment, which remains in force in spite of the statutory remedies referred to, a master is only liable to his servant for damage resulting from his own personal negligence.

Such negligence may arise on the part of the master in any of the following ways :—

(*a*). By the employment of another servant with the knowledge that he is incompetent.

(*b*). By the retention in his employment of a servant known to be habitually negligent.

(*c*). By allowing plant on the premises to be in a dangerous condition.

(*d*). By the breach of an absolute unqualified duty imposed on the employer by Statute to do something for the protection of workmen.

In order that a servant may obtain his remedy under the doctrine of Common Employment there must be both a common master and common employment under that master.

The effect of "The Employers' Liability Act" is to give a workman, as defined by the Act, who suffers an injury by reason of certain specified acts of negligence a remedy against his master, as if he were not his servant but had merely entered upon his premises.

And under "The Workmen's Compensation Act" the liability to pay compensation arises independently of any neglect or wrongful act (otherwise than wilful misconduct) on the part of the master or the servant injured.

There is a difference in the amount of compensation an injured workman may be awarded according to whether he sues under the old Common Law, or seeks his remedy under the Workmen's Compensation Act ; in the latter case a County Court Judge deals with the matter in the capacity of an arbitrator. In the former case the

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amount of compensation depends on the amount of the suffering caused to a workman and the expenses of his illness, and the remedy under the Common Law may therefore prove more advantageous to the workman where he has a good cause of action than the remedy under the Act; in the latter case the amount payable is fixed by scale and represents the difference between his wages and earning capacity before and after the accident. It is, as a rule, not difficult for an engineer to take such precautions that, in the event of an accident unfortunately occurring, the workman can have little hope of success in an action under the Common Law. The Workmen's Compensation Act has however considerably modified the old law since it has given the employé very extensive protection, and the only safe course for the employer to adopt nowadays, is to protect himself fully by means of Accident Insurance policies. It must be remembered that under this Act even where the workman has been negligent, or has acted contrary to his master's instructions, yet even in such circumstances the County Court Judge, acting as an arbitrator, may make an award in the workman's favour.

Brief as the foregoing references are, I hope that I have succeeded in putting before you in sufficient detail the more important points relating to the Law of Torts which may prove useful to you at the commencement of your careers. In later years, your every-day work will familiarize you with other aspects of the subject, and I can only hope that the accumulation of knowledge in your case will be gained rather at the cost of other people than at your own expense.

Knowledge of Law of Contracts Essential to Engineers.

I now propose to say a few words concerning the Law of Contracts. Probably during the whole of your professional career you will be concerned with the making and performing of contracts, and therefore a knowledge of this branch of the law is really a fundamental necessity to you. It is difficult to frame a sufficiently broad definition to cover the many varieties of contract, and indeed almost as many definitions are to be found as there are varieties of contract.

Put very briefly a contract is an agreement enforceable at law to do or to refrain from doing a certain act; it may be made by deed, writing, or word of mouth. A contract really consists of an offer made by one party, and acceptance of that offer by the other party to the contract; and in all cases there must be evidence that the minds of the parties have come to an agreement about exactly the same thing; therefore an offer which is not communicated to the other party is of no legal value.

The importance of a contract, from the standpoint of law, lies in the fact, that, whereas it is created by the voluntary act of the parties

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thereto, yet, once made, the Courts will enforce it with the same strictness as if it were part of the Statute Law of the land. The Courts extend no protection to the maker of an improvident contract, except in the cases of certain persons, who, for their own protection, are by law declared incapable of entering into a contract. This class comprises infants, lunatics, intoxicated persons, and persons under duress. The law presumes that in making a contract the parties are best able to settle its terms, and, although these may prove oppressive to one party or the other at a later date, yet this is a consideration that can rarely influence a Court of Law which, in the general interests of commerce and industry, rightly endeavours to jealously guard the inviolability of rights acquired by the terms of a contract.

You are all probably aware that in ordinary cases in order to make a binding contract it is strictly necessary to enter into a definite agreement either in writing or by word of mouth; however, if a person goes into a shop and orders goods, the law implies that he has contracted in such a case to pay the reasonable value for the same. Contracts of this nature are termed implied contracts in contradistinction to express contracts, the terms of which are openly expressed.

Implied contracts sometimes present complex problems when questions arise as to whether an individual has not made himself liable to certain obligations by his conduct, although he may not have intended any such result to follow. It is only necessary to warn you here that before accepting a benefit of any kind, it is always as well to ascertain exactly what liability you may be incurring in respect thereof—it is rarely one gets something for nothing in this world.

Express contracts are divided into two classes, namely those made under seal and those not so made. The former class are referred to as specialty contracts, whilst the latter are termed simple, or parol contracts. Simple contracts differ in two important respects from specialty contracts :—

(1). In the case of a simple contract there must be some consideration to render it valid, whilst in the case of a specialty contract it is the form in which it is made that renders it valid apart from consideration.

Consideration in the legal sense may be defined as some benefit to the person making the promise, or some loss, trouble, inconvenience to, or charge imposed upon the person to whom the promise is made. Although consideration is essential to the validity of every promise not under seal, and must move from the promisee, it need not be adequate as long as it is of some ascertainable value, legal, and not past.

(2). The second important difference is that, whilst an action on a

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simple contract is barred by the Statute of Limitations in six years, on the other hand an action on a deed or specialty contract is only barred after the elapse of 20 years.

Any person, with the exception of one of the class coming under the disabilities referred to earlier in this lecture, may enter into a contract in relation to any subject matter as long as the same is not contrary to law, morality, public policy, or, within certain limits, impossible. Attention has been drawn to the fact that the Courts have always endeavoured to protect the inviolability of contracts; and this has naturally led to the rule that the agreement on which a contract is based must indeed be a real one in every sense of the word; so that an agreement secured either under mistake, or by undue influence or misrepresentation, duress or by fraud do not fulfil this test, and hence are rendered either voidable at the option of one party or absolutely void. The difference between a voidable and void contract lies in the fact that in the former case one of the parties may at his option either treat the agreement as binding on him or not, whereas in the latter case, the situation in the eyes of the law is simply that no contract at all has been, or could have been made. A great deal more could be said on this aspect of contracts, but the time at our disposal can perhaps be better utilized in touching briefly on several of the more important aspects of the subject rather than going too fully into any one particular matter.

The next point which may usefully be considered here is that connected with the circumstances under which one or other of the methods of entering into a contract referred to should be adopted. As a matter of fact we have not in every case a free choice in this matter.

The Common Law and certain Statutes provide that in particular instances agreements must be under seal, in others that they must be in writing, or in some cases supported by written or other statutory evidence, whilst the remainder may be made verbally or by conduct.

The kinds of contracts, of most interest to you, which are subject to restrictions of form are :—

(1). At Common Law, the contracts of Corporations.

(2). Partly by the law merchant and partly by Statute, the contracts expressed in negotiable instruments.

(3). By Statute only :—

(i.). Contracts under the Statute of Frauds.

(ii.). Contracts under the Sale of Goods Act.

(iii.). Insurances.

(iv.). Acknowledgment of debts barred by the Statute of Limitations of James I.

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(1). *The Contracts of Corporations.*—The general rule in such cases is that the contract must be made under the Common Seal of the Corporation. There are exceptions to the rule in the case of trading corporations which may make without seal any contract which is incidental to the ordinary conduct of their business. Similarly, a non-trading corporation, if expressly created for special purposes, may make without seal any contract incidental to those purposes.

Corporations have at times endeavoured to take advantage of the technicalities of the law to repudiate their obligations, but the Courts have laid it down that a corporation is bound by an obligation implied by law when an individual would be. It behoves engineers who enter into contracts with corporations to take care that all the formalities of the law have been complied with so as to ensure that such contracts are binding. The Courts have, it is true, ruled, that where an engineer has done work or rendered services at the request of a corporation in respect of matters for the doing of which it was created, and the corporation has accepted the benefit of the work and services, the law will imply a contract on its part to pay for the same, and, in consequence, the absence of a contract under seal will not be accepted as an answer to the action. But still, there are circumstances under which the Courts cannot act upon the foregoing equitable principle owing to the existence of Statutes which prescribe a special form which must be obeyed.

Thus by Section of 174 of the Public Health Act, 1875, every contract made by an urban authority, whereof the value exceeds £50, shall be in writing and sealed with the common seal of such authority. The effect of this provision is that without the seal the contract is void, and that an urban authority may make a contract, reap the full benefit, and then decline to pay. Cases falling under the provisions of the foregoing Statute are on record in which engineers have been victims of their own carelessness, that is to say, owing to their failure to observe that the requirements of the law had been complied with so as to protect their interests, engineers have, at times, failed to obtain a judgment in Courts of Law for remuneration in respect of services actually rendered by them. I can only hope that no unfortunate experience of this kind may ever befall you.

(2). *Negotiable Instruments.*—The peculiar contracts entered into by persons who issue or endorse negotiable instruments, that is bills of exchange, cheques, and promissory notes, must by the nature of the case be in writing. Part of the definition of a bill of exchange is that it is an unconditional order in writing. The acceptance of a bill of exchange, though it may be verbal as far as the law merchant is concerned, is required by Statute to be in writing and signed. This subject is a difficult one to deal with in a few words. I can only urge you to exercise, at all times, the greatest caution in dealing with

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documents which purport to be negotiable instruments, hidden dangers often lurk in transactions in which such documents play a part.

(3). (i.). *Statute of Frauds.*—It is the provisions of the 4th Section of this Statute which are of most interest to engineers. These provisions require that in certain classes of cases no action upon an agreement can be brought unless there is some memorandum or note thereof in writing, and signed by the party to be charged therewith or by some other person thereunto by him lawfully authorized.

I need only draw your attention to the following three sorts of contracts within the mischief of this section :—

(*a*). A promise to answer for the debt, default, or miscarriage of another person. This is what is known as a contract of guarantee ; and the real object of the contract must be the payment of the debt of another. What you have really to be careful about is, that when a third person undertakes to be responsible to pay for goods which you have sold to another, if this latter person should fail to meet his liability to you, be exceedingly careful that you get this third person to give you his undertaking in writing, otherwise you may be disappointed at a later date. It should be clearly understood that the terms "default" or "miscarriage" refer to wrongful acts creating a liability for damages which are not breaches of contract.

(*b*). A contract of sale of lands, or any interest in or concerning them. The difficulty in this section has been to say what are "interests in or concerning lands." It has been held that an agreement for a person to take water from a well comes within the mischief of the Act. In view of this provision of the law, just consider for a moment what your position would be if you had commenced and completed a generating station, on a site adjacent to the property of a landowner possessing the only available water supply within several miles of the station, on the faith of a verbal understanding with him that he would allow you to obtain your water from his land, and then if he should repudiate the agreement just after your plant is completely installed. Clearly, it would be useless for you in the present state of the law to seek your remedy in any of our Courts of Justice. The subject is too wide to be further dealt with in this lecture, and I can do no more than just draw your attention to the matter here in order that you may be on your guard. Being forewarned, you can readily seek legal advice in all cases of doubt.

(*c*). Agreements not to be performed within the space of one year from the making thereof. This clause of the Statute has provided and continues to provide much material for actions in our Courts. The clause clearly refers to agreements, which from their terms are incapable of being completely performed within the year, and does not apply to those contracts which may be performed on one side within the year though they cannot be performed on the other in

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that time. I can only warn you that, in spite of the apparently simple language of the Statute, a considerable amount of care requires to be exercised to determine whether an agreement is within or outside the mischief of this clause. The only other matter I need draw your attention to in connection with the above clauses of the 4th Section of the Statute of Frauds is, that the Statute is satisfied so long as there is a note or memorandum relating to such contracts in writing by the party to be charged or his agent, and that the Statute does not prescribe that the specified contracts themselves shall be in writing.

(ii.). *Sale of Goods Act*, 1893.—Section 4 of the Act which replaces Section 7 of the Statute of Frauds enacts that:—

(*a*). "A contract for the sale of any goods of the value of £10 or upwards shall not be enforceable by action unless the buyer shall accept part of the goods so sold, and actually receive the same, or give something in earnest to bind the contract, or in part payment, or unless some note or memorandum in writing of the contract be made and signed by the party to be charged or his agent on that behalf."

It would seem that when specific goods are sold without regard to the provisions of the Statute, the property passes to the buyer. The purchaser cannot under such circumstances sue the buyer for the price, but if the latter declines to pay, the only course is to treat the contract as rescinded, in which case the property will revest in the original owner.

(iii.). *Insurances.*—The Marine Insurance Act, 1906, requires that policies of Marine Insurance shall be in writing, and that only persons who have an insurable interest in a marine adventure shall be permitted to take out a policy.

It is well to remember that a higher measure of good faith is required from both parties in contracts of this nature than in the case of ordinary contracts. Conditions are implied from the nature and not from the words of the written contract, and terms are incorporated from the conversations of parties, though appearing nowhere in the policy.

The above remarks apply generally to fire insurance policies also.

(iv.). *Acknowledgment of Barred Debts.*—The operation of the Statue of Limitations of James I. in taking away the remedy for a debt may be excluded by a subsequent promise to pay it, or an acknowledgment from which such promise can be implied. The promise or acknowledgment if express must be in writing,—it naturally must be made within six years, unless there is a new consideration—and signed by the debtor, or his agent duly authorized. The reference to this matter will show you the importance of carefully preserving any correspondence which may pass relating to debts of the class referred to here.

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Discharge of Contracts.

Contracts may be discharged by :—

(i.). Agreement.
(ii.). Performance.
(iii.). Breach.
(iv.). Impossibility.
(v.). Operation of law.

(i.). *By Agreement.*—As an agreement makes, so can it unmake a contract. It is the act of both parties and results in the rescission of a contract. Where neither party has done his part it may take the form of a release ; where, however, one party has performed his part, and the other has committed a breach, the release must be supported by a new consideration which if "executed" is termed an accord and satisfaction, otherwise the release must be under seal. The parties to a contract can also by agreement alter it or substitute a new one for the original. Agreement is a matter of fact and may be inferred from the conduct of the parties.

(ii.). *Performance.*—When both parties have done what they originally agreed to do, the contract is at an end and discharged. This matter requires no further comment.

(iii.). *Breach* of a contract gives a cause of action against the offending party. What amounts to a breach is in some cases a difficult question to determine. The party who suffers damage by the breach of a contract is entitled to pecuniary satisfaction in the event of his success in an action at law. The important matter to remember in this connection is that, in cases of contract, it has been laid down as a proper rule for the Courts to follow, that the damages, which the injured party ought to receive in respect of a breach of contract, should be such as may fairly and reasonably be supposed to have been in the contemplation of both parties at the time they made the contract as a probable result of the breach.

The last sentence is important ; what it amounts to is that if, at the time of making a contract, one party makes known that in the event of a failure on the part of the other party to fulfil the contract there are special circumstances which will involve abnormal loss to the injured party, then, in the event of a breach of contract actually occurring, the Court in assigning the amount of compensation to be paid to the successful plaintiff will take the special circumstances into account. Where the defendant is kept ignorant of any special circumstances the Court will always disregard the same in determining the compensation. The moral is, that when making a contract, be sure to let the contractor know of the existence of all special circumstances connected therewith.

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(iv.). *Impossibility.*—Where it becomes impossible to perform a contract subsequent to the making thereof, a party is not necessarily discharged from his liability in respect thereof, because in making the contract he might have guarded himself against such an accident. This question is somewhat technical and it would be unprofitable to attempt further to deal with it in the short time at our disposal.

(v.). *By Operation of Law.*—The law operates to discharge contracts in certain cases. All contracts for personal services which depend on the life or health of the party contracting are subject to the implied condition that he shall be alive, or in good health to perform them. Death or ill-health, in such cases, operates as a rescission of the contract.

Similarly, in cases of bankruptcy, an order of discharge releases the debtor from all debts provable under the bankruptcy, whether in fact proved or not. There is another class of cases to which the term "merger" is applied. This amounts to the substitution or acceptance of a security which in the eye of the law is of higher operative value, in place of another. For instance, a simple contract may be merged in a specialty, if the parties embody the terms of an existing contract in a deed. Further, if an action is brought on a specialty or simple contract and judgment is recorded thereon, these are merged in the judgment. In the case of a default of the loser, the winner brings any further action on the judgment and not on the original contract.

There are many other matters relating to contracts which are of considerable importance to engineers, but I must content myself with a reference to one more matter only, namely, that relating to the construction or interpretation of contracts.

CONSTRUCTION OF CONTRACTS.

Perhaps there is no duty which an engineer is called upon to undertake which is a more responsible one and requires greater care than the framing of a contract. The importance of the choice of the correct words, and their proper collocation, cannot be exaggerated, for when a dispute arises between the parties to a contract all that a Court of Law can do is to interpret the language contained in the document, which purports to set out the matters on which the parties actually came to an agreement. A moment's reflection will show the serious inconveniences which would arise if the practice was otherwise, and if the parties to an express contract were allowed to argue that language deliberately employed in the written document did not actually set out their intentions.

It is well therefore for an engineer before he signs a contract to analyze closely the expressions which are employed therein, so that he may make certain that the phraseology is so clear, and the terms

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so explicit, and every contingency provided for that, if submitted to a Court of Law, the language employed will support the interpretation which he desires shall be put upon it.

Disputes often arise from the fact that the parties to a contract are mistaken in their ideas of their obligations thereunder; it is always a wise precaution in all important dealings to seek legal advice, and in none more so than in the preliminary stages of a large contract, so as to ensure, as far as it is possible to do so, that the real intentions in relation to the contract appear in clear and unambiguous terms. And, where this result has been successfully obtained in the instrument containing the terms of the contract, you may rest assured the Court will give full force and effect to the same, and will not allow any explanation to vary or alter the explicit statements forming the contract. The theory naturally being, that the parties are presumed to know what they intended at the time they entered into the agreement, and chose words to express their requirements with the greatest deliberation and care, and, in consequence, such intention must prevail however burdensome or disagreeable the conditions may prove at a subsequent period. On the other hand, if the matters in dispute are only partially covered by the terms of the contract, and the phraseology employed is susceptible of two or more interpretations, it becomes the province of the Court to determine what meaning must be attached to the language in the instrument. A number of broad rules have been established to guide the Courts, and, in consequence, should be borne in mind by those whose duty it is to frame documents which have a legal value.

These rules are as follows:—

1. Persons are presumed to contract with reference to the habits and customs of a locality, and the Court will take cognizance of such particular usages or customs affecting the subject matter of a contract, unless their operation is excluded therefrom by express words.

2. The words in an instrument will be given their ordinary and commonly accepted meaning, unless from the circumstances of the case it appears that they were used in a special sense.

3. Where the subject matter of the contract concerns a particular trade or business, words having reference thereto will be given the meaning usually ascribed to them in such business or profession.

4. The best way of getting at the meaning of an instrument is to ascertain when and under what circumstances it was made; the Court will have regard to such circumstances to arrive at the real intent of the parties, and will give force and effect to such intention.

5. Where the language of a written instrument is perfectly plain no construction will be put upon it to contradict the language.

6. The contract will be construed reasonably, *i.e.*, not merely the literal meaning, but also the true meaning will be examined.

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7. The construction will be on the entire instrument, that is, one clause will not be looked at alone, but the context will be taken into consideration.

8. The language of an instrument will be always construed strongly against the person whose language it is.

The rules are logical and contain the principles of fairness and equity, and I cannot do better than commend them to your serious attention.

CONCLUSION.

I have endeavoured to put before you very briefly some of the salient points of our Common Law. It has been said that lawsuits originate more in the gross misconception of litigants, in their mistaken notions of each other's rights and liabilities, than in positive dishonesty and bad faith. I can only trust that the remarks I have made may prove sufficiently useful to remove to some extent such misconceptions in your case, and help to free you from the burden and anxieties of litigation in your future career.

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TRANSCRIPT.

TRENCHES IN HILLS.

Extract from an article entitled "The Influence of the Pyschical Element in Conjunction with other Factors, upon Fortification Types," by V. Polyanski in the May, 1912, number of *Injenerni Jurnal.*

THE siting of trenches in hills offers greater difficulties and complications than does that of trenches in level or rolling ground, and as hilly country is so often met with, a satisfactory solution of the questions of what types are applicable, how they are to be applied to the ground, and how concealed, is clearly necessary.

These questions are complicated by the following conditions:—

(1). *The Soil.*—Among hills this is generally rocky with a thin top layer of disintegrated rock, or, in exceptionally favourable circumstances, stony or gravelly. Earth is found only in ravines, sand and occasionally gravel in river beds. In such conditions, with the *rapid* (one night) fortification of a position, in the most favourable case one cannot count upon making a trench deeper than for occupation *kneeling*. With provisional fortification, and with the help of explosives and large entrenching tools, deeper profiles might be excavated.

(2). *Concealment.*—This is much more difficult than in level ground, where the works are seen against backgrounds of other works or of local objects, and the atmosphere is often thick enough to make observation difficult. Here the air is clearer, orientation is simplified, and worst of all lights and shades quickly expose the positions of parapets and trenches.

(3). *Vulnerability.*—The steeper the hill slope the more direct is the exposure of works constructed upon it to the action of hostile shells. Taking into consideration that ranging is more easy and that firing can be continued much later without injuring the assaulting troops, it is easy to conclude that the percentage of hits in trenches sited on hills will be considerably greater than in those on level ground. These three conditions govern the siting of trenches on hills. Hitherto the textbooks have laid down that trenches must be sited where they can obtain the best fields of fire over the front-lying ground, and also if possible the best concealment. For this they should be pushed down the front slopes to the line which is commonly known as the "military crest."

A few years back however a pamphlet was published in which the author severely criticized the standard system, and among other things insisted that rifle trenches should be sited on the topographical crest, where they would retain the distant and near (50 to 60 paces) fields of fire, but sacrifice the command of the lower slopes in their front. In

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special cases he even considered it possible to occupy reverse slopes. The following reasons are given for this opinion:—the impossibility of concealing trenches on a front slope, the facility of their destruction by artillery fire, the absence of cover even from shrapnel, the difficulty of manœuvre and of communication with the rear.

This pamphlet raised a storm of controversy, the supporters of the standard system maintaining that the siting of trenches on the military crest must remain a fundamental rule, as it is impossible to allow large areas of dead ground in front of the trenches, and it is essential that the garrison should be able to watch the advance of the hostile attack. Instances from the Russo-Japanese War quoted in the pamphlet, where trenches thus sited were untenable under artillery fire, and where the trenches were demolished and their defenders slain, are true of trenches giving but kneeling cover, but not of trenches of deeper profile which were not demolished and gave ample protection against shrapnel fire. But a glance at the conditions will show that whereas one side was arguing from the point of view of rapid fortification, the other was considering only the conditions of provisional.

The troops must occupy the best firing position in which adequate cover is obtainable. If troops not protected by trenches are posted on the military crest, where they will obtain cover neither from the fire nor even from the view of the enemy, the first rounds of shrapnel will send them flying for shelter behind the topographical crest, which, though a bad firing position would have become for them the only possible one. Trenches which give only lying or kneeling cover do not alter the case. They do not give protection from shrapnel fire and splinters, rifle bullets penetrate their parapets, and it is impossible to conceal them. This was repeatedly experienced in the war in Manchuria. Trenches on the military crest which give only kneeling cover are impracticable, during the artillery bombardment the troops who occupy them must be withdrawn to the reverse slope, and as the bombardment is continued almost up to the time of the bayonet charge it is hardly probable that these trenches will be re-occupied in time. Under the conditions of *rapid* fortification, the firing position must be the topographical crest, and here there should be merely screens, connected with secure shelters in rear of the crest. Dead ground in front should be avoided by the mutual protection given by the combined siting of trenches, by concealed flanking batteries of machine guns, by hand and rifle grenades, artillery cross-fire and by land mines.

Trenches of deep profile on the military crest are not easily demolished by the fire of field guns, and sometimes allow of the defenders being kept in them during the artillery bombardment, though it must be admitted that they do not give security against the shrapnel fire of howitzers. But well-concealed communication trenches are a necessary adjunct to such trenches—these arteries of modern battle by which reinforcements are introduced, troops retired, stores brought up and the wounded removed. In the absence of communication trenches the *moral* of the troops is affected, and they cannot be trusted to await the hand-to-hand encounter.

The influence of the psychological element is well shown in the following words of Colonel Dorokhin, who took part in the late war:—

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"Frequently the trenches were sited far down the hillside. In the majority of cases it was impossible to communicate with them. The men knowing this could not endure it, and evacuated them. We tried punishments, prayers, threats, but all to no purpose. The troops either deserted them or were killed, and the trenches, as happened in my sight at Liau Yang, were demolished off the face of the earth. Occupying the crest and without any trench, I suffered loss from the enemy's artillery fire, but none the less I succeeded in defeating all the efforts of the Japanese to carry the crest. The attackers had to clamber up the hill, and before they reached the crest they were generally exhausted. In fact the slope of a steep crest line as an obstacle does not yield place to a wire entanglement."

Trenches sited on a front slope should also be fitted with defensive casemates, which would allow the defenders to open fire on the attacking infantry in spite of high-angle shrapnel fire, which might continue up to the bayonet charge. But trenches of deep profile, communications and casemates are realizable only under the conditions of *provisional* fortification, and they must be ideally concealed. If the attack has howitzers or guns of large calibre, all kinds of trenches on the military crest will be soon demolished. The garrisons would have to be withdrawn, and it is doubtful if they could ever be brought back under the fire of howitzer shrapnel.

It appears therefore that the siting even of provisional works on hillsides well seen by the enemy is unwise. Commanding heights are extremely important in modern hill fighting as observation stations. It frequently occurs that the whole fate of a battle turns on the struggle for some hill or other. The moral value of such observation posts is immense. The emptiness of the modern battlefield creates extremely difficult conditions for directing the fight, even for the junior commanders, and it is extremely probable that both sides will direct all their energies towards the capture of such a point, from which something can be seen and bearings can be adjusted. The side which possesses such points at once gains great advantages, and this is instinctively recognized even by the rank and file. So that the varying incidents of the fight for such a hill top are clearly reflected in the spirits of the troops.

Commanding heights must therefore be resolutely defended, but this does not necessarily mean that they must be covered with works of defence. The experience of the Russo-Japanese War shows that if works of defence are plainly visible (and on hills they undoubtedly will be so) they will be quickly demolished by artillery fire. The heights should be defended by arranging to command the approaches to them from neighbouring parts of the position. On the heights themselves there should only be ideally concealed observation stations, and on their reverse slopes secure shelters.

The question of the selection of a firing line on hills, therefore, is answered apparently in the following manner:—In cases where the time allows the construction of trenches only of weak profile, or if the enemy possesses guns of large calibre, the rifle position should be the topographical crest, every endeavour being made to conceal the defenders

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from the enemy's view. The best firing positions have to be sacrificed, and we have to be content with what is possible and trust to the ground in front being commanded by cross-fire from neighbouring trenches, by hand or rifle grenades, mines, etc. The most important defence works must include earth screens for riflemen, shelters on the reverse slopes, and paths for rapid and unimpeded communication along the front and in the depth of the position.

Under the conditions of provisional fortification when there is time to excavate trenches of deeper profile, with defensible casemates and communication trenches, when all works can be ideally concealed, or when the enemy is known to possess no guns of large calibre, the trenches should be sited on the best fire position, the military crest. But as on the one hand ideal concealment on the military crest can be obtained only under exceptional circumstances—a trench, for instance, without parapet on a fold of the hillside—and on the other, in an attack on a provisionally fortified position guns of large calibre, up to 8 in., will probably be used, and as provisionally fortified positions for large forces are exceptional, we may lay it down that the siting of trenches on the military crest must be considered not as the rule but as the exception.

F. E. G. SKEY.

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NOTICES OF MAGAZINES.

Militär Wochenblatt.

The Development of Flying in the Half Decade 1908 to 1912 and its Military Significance.

The following is a *précis* of an article with the above title by Capt. E. Schmidt in the *Militär Wochenblatt* No. 34 of 15th March:—The development of flying tends to make its uses more and more exclusively military. Its possibilities for reconnaissance have increased enormously. Aerial reconnaissance will be particularly valuable against the artificial tactics of the French, with their strategic advanced guards and advanced positions, and their dependence on the sudden and unexpected shock of great masses. Aerial reconnaissance will also be most valuable in fortress warfare to discover the progress of the defenders' works. The use of aircraft for offence, except against hostile aircraft, is gradually taking a secondary place. In the Navy hydroplanes, that can be employed in a rough sea and yet can be stowed on board a warship, are being developed. It is most desirable that aircraft should be completely independent of the surroundings of temporary resting places and should be able to rise vertically. In any case aeroplanes must be built so as to be able to rise from uneven and cultivated ground with a very short run. The author states that whereas English aeroplanes require a run of 200 to 300 yards to get off the ground, the German biplanes at the Berlin Flying Week, October, 1912, only took, on the average, 82 yards, and the monoplanes 132 yards. Aircraft to keep out of reach of hostile fire must travel at least 1,000 metres (3,280 ft.) above the ground, unless they can get the shelter of a cloud. At this height they are also freer from disturbances of the air. Every year shows aeroplanes going higher and higher; in 1912 a height of 19,000 ft. was reached. The speed with which aircraft can rise is of great military importance. The Zeppelin "Victoria Luise" can rise 3,280 ft. in four or five minutes, and thus ought to be able to escape from hostile aeroplanes which can only climb at half this speed. Yet owing to loss of gas at great heights airships cannot ascend as high as aeroplanes. The altitude record for airships is that of the French dirigible Conté—3,025 metres (9,924 ft.). The speed of aeroplanes has greatly increased. In 1909 the record was 47 miles an hour; in 1912, 109 miles. The importance of speed is that the quicker the machine flies the less it is affected by the wind. High speed does not prevent accurate reconnaissance, in fact by flying in a circle round the area, which can be done with little loss of time, better observations can be made than by a flight across it. The disadvantage

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of high speed is the danger of landing, for a fast machine easily turns over. The time that a machine can remain in the air has greatly increased. In 1908 the record was 2 hours 20 minutes; in 1912, 13 hours 17 minutes. In the same period the distance travelled in a single flight rose from 77 miles to 630 miles. The weight-carrying capacity of aeroplanes has increased. The author discusses the causes of accidents and classes them as due to atmospheric causes, over-fragility of build, and motor trouble. He concludes by saying that all this progress is useless unless the *personnel* is trained to make the fullest use of the improved *matériel*.

"E."

Rivista di Artiglieria e Genio.

November, 1912.

Some Reflections on Siege Warfare.

An article by Colonel Rouquerol in the *Journal des Sciences Militaires* (15th September to 1st October) is well worthy of attention, the author being famous on account of several important publications on the employment of field artillery.

The author commences by distinguishing the differences that exist between the fronts of the attacking and defending forces. The assailant being master of the external ground can select the method of approach best adapted to the particular case. Moreover he can remedy his errors, abandoning an attack that is badly conceived or does not prove successful, in order to seek a better issue at another point. For example, the Japanese at Port Arthur, finding their efforts against Dragon Hill useless, turned their attacks against 203-Metre Hill. The defenders, however, are not able to refuse the conditions of strife offered by their adversaries. The defending troops in a regular siege are numerically inferior to those of the attack, and would have few mobile batteries, owing to the difficulty of feeding the horses. Besides this, artillery would not have the facilities for manœuvring, and it is on such facilities that the advantages of modern artillery so greatly depend. The assailants on the other hand would possess a strong proportion of the best field artillery.

The material of the artillery of the place will not always be of the most recent pattern, or that best adapted for the conditions of defence; the place should be able to sustain the siege with the material that it possessed previous to the commencement of the attack. The assailants, however, can prepare the material necessary for the proposed attack a few weeks before the commencement of operations.

If errors in the preparation of the park arise, owing to an inexact appreciation of the means of resistance of the place, these can be corrected before the siege operations are begun. For instance at Port Arthur, at the commencement, the siege park did not possess shells of large calibre, and the Japanese had not cannon of this kind. But the want of heavy

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shells was soon felt for the purpose of destroying the cemented covered ways, and such shells were brought to the batteries from the coast armaments. During a war of a certain duration the assailants can procure guns of a new pattern, while the defenders of a besieged place are not able to reinforce their armaments. The same applies to ammunition. The assailants can always replace that which is expended, incurring only the risk of lessening their fire. But the defenders after a long siege are restricted from a day's exceptional consumption of ammunition, by the reflection that they will not be able to continue the fire on the following days.

Between two adversaries having such unequal conditions, the strife cannot be long without the assistance that the defenders obtain from fortifications. These conditions have always been found to hold good, and they are more marked by the power of modern artillery, which makes it more than ever necessary for a place to have a means of defence adequate to that of the attack. While in the past it was possible to organize an efficacious defence with improvised means, to-day only permanent fortifications can resist the projectiles of siege artillery.

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To form a correct idea of what is required for the defence of a modern place, it is first necessary to take account of the means and the power of the attack.

All the great European Powers possess not only organized siege parks, but also light parks which are able to follow the troops in the field. Germany can dispose of three principal centres, Metz, Cologne, and Thorn, with siege parks ready to be placed on the railways, and she has besides 120 batteries of foot artillery with guns of 15 to 20 c.m. The mobilization of these batteries require five or six days, so that a mass of artillery of medium calibre can march behind an army intended for the investment of a fortified place. It would be absurd to suppose that improvised works or antiquated walls would be able to resist the shells thrown from these guns.

Those who would attempt to remedy an initial error by substituting earth, wood, or rails for cement and armour, show that they are ignorant of the effects of modern artillery. In case of necessity it is possible to profit by such occasional means, but in front of an energetic attack such resistance cannot be relied upon.

The long resistance made by the Visokaya Redoubt (on 203-Metre Hill), may be cited, but it must be remembered that the guns which were brought to bear upon this position were put out of action before their fire had given any useful result, and that in the end the material resistance of the work would have been of small value without the constant intervention of reinforcements, and especially without the action of vigorous counter-attacks. Actually the redoubt fell long before the capture of one of the permanent forts.

This experience shows that valour and expenditure of life will be of little service in correcting errors in the construction of permanent fortifications. The engineers at Port Arthur, after having multiplied the cemented works on Dragon Hill, had trusted to 203-Metre Hill as an active

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defence to assist the semi-permanent fortifications. It is impossible to say what would have happened if the Japanese had attacked Visokaya by mining, and had employed means for destroying the scarps and the flanking defences; perhaps the besieging army would not have been able to take part in the Battle of Mukden. In fact, from the conditions to which we have referred, it would seem that the investment of a strong fortress should proceed much more rapidly than in the past.

Local fortifications, fieldworks, all the obstacles for a weak resistance which form objectives for artillery fire, have lost their importance in the siege warfare of to-day. Against a walled fort wanting in flanking defences and more or less in a ruined state, an assaulting column can seek to overcome the scarp by means of scaling ladders and by crossing the ditch by flying bridges. But the assailants, who wish in this manner to capture a strongly cemented fort provided with flanking caponiers, well arranged, would certainly be stopped by the fire of quick-firing weapons of small calibre placed in action by the defenders.

It is not necessary for the forts to have an armament of medium calibre nor a numerous garrison, to compel the assailants to an attack step by step. They should be so constructed as to render the defenders absolutely secure from bombardment, and to allow for the action of arms of small calibre from sheltered positions. Under such conditions the assailants can only have recourse to the old system of mining to attack the cemented masses which cannot be ruined by artillery fire. The assailants can, however, try to penetrate into the interior of the place by passing between two forts. Such an undertaking should essentially constitute an attack *de vive force*, as its success depends upon special circumstances, such as mist or the negligence of the defenders. But it would be rash to organize an attack of long duration advancing as a wedge between two forts. When the mists disappear the defenders would be masters of their defences and the assailants would find themselves exposed to disaster.

The assailants have at their disposal guns having a range of from 12 to 15 k.m. with which they can bombard and damage the besieged city, depressing the *morale* of the population and continually disturbing the repose of the garrison. The defenders, who wish to make sorties from the place in order to confront the enemy in the open, would, even with the assistance of the works, find themselves in such inferior force that they would certainly be beaten, perhaps compromising the possession of the place. In a siege conducted by enterprising assailants and sufficiently provided with artillery, the probable result of the occupation of an advanced position by the defenders would be its abandonment with material losses, and grave and important moral consequences.

An advanced position, organized after the commencement of the war and distant from 2 to 3 k.m. from the lines of forts, constitutes a trap which the defenders prepare for themselves. The active defence should be undertaken in quite another manner, and according to Rouquerol should take the form of a continued series of counter-attacks. These should commence as soon as the siege enters into the region of small operations, and should be continued up to the last day of the siege. Surprise and rapidity are the principal conditions of their success.

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The endeavours of counter-attacks should be to destroy any detachments pushed forward in advance of the besiegers; to cause panic in a cantonment or encampment; to ruin the earthworks and material. In counter-attacks, more important results can be obtained with small detachments than with larger masses, which are less manageable.

The author holds that the force to be employed in a counter-attack should not exceed one battalion, and should not comprise artillery if there is any danger of the carriages impeding the operations. It is desirable for the defence to have detachments of pickets always allotted to the counter-attack, and ready to move at the first signal so as to seize upon all occasions of injuring the enemy. It is of the greatest importance that the defence should have perfectly organized systems of obtaining information, by means of which it can be informed with security of all the enemy's movements; the same *personnel* should guide the counter-attacks and perform the service of exploration. Inhabitants of the country, having practical knowledge of the locality, would be useful for this purpose.

It is strongly recommended that, for a garrison consisting of one army corps, the force allotted for the reserve should consist, approximately, of a brigade. The garrison of a place is necessarily composed of elements drawn to a great extent from the reserves. These troops are at their best when they have a certain cohesion and are well in the hands of their leaders. But if these troops are employed as workmen they cannot be formed into a solid unit. In the case in which the enemy does not leave time to complete the works and to prepare for combat, the resistance of the place, notwithstanding a considerable garrison, should be passive. The defenders would be wrong if they desired to give up all active manœuvres by the whole of the garrison, while the fortress is not placed in a complete state of defence. By doing so they would possibly have abundance of defensive works; but they would not have soldiers, and these being wanting the place would remain inert.

The author holds that it is preferable that the works required to put the place into a state of defence should remain incomplete, rather than that the services of a well-instructed general reserve should be lost in completing them.

E. T. THACKERAY.

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RECENT PUBLICATIONS OF MILITARY INTEREST.

REVIEW OF BOOKS.

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HISTORY.

RUSSIAN OFFICIAL HISTORY OF THE RUSSO-JAPANESE WAR, VOL. II.,* PART I. (Guerre Russo-Japonaise 1904–5. Historique rédigé à l'état-major général de l'armée russe). 759 pp., with 17 maps. 8vo. Paris, 1912. Chapelot. £1.

Vol. II. comprises the first period of the campaign, and its Part I. deals with events from the commencement of operations to the Battle of Wafangkou (Te-li-ssu) exclusive. It therefore covers the period dealt with in Vol. II., Part I. of the Russian original, the text of which is rendered almost word for word.

The Official History of the Russo-Japanese War, prepared by the Historical Section of the Committee of Imperial Defence, is quoted as the authority for much of the information regarding the movements and operations of the Japanese troops.

The Introductory Note (*Note concernant la Traduction*) contains useful information regarding the spelling and meaning of names and terms, Russian and Chinese, and the organization of the Russian Staffs and units.

The table of contents, which is to be found at the end of the volume, gives the following chapter headings:—

Chapter I.—Military geographical survey of the theatre of operations.
Chapter II.—Review of the general situation in the theatre of war at the commencement of operations.
Chapter III.—First period of operations up to the date when General Kuropatkin joined the Army, March 28.†
Chapter IV.—Second period of operations, from the date when General Kuropatkin joined the Army till the Japanese were on the point of crossing the Ya-lu.
Chapter V.—The Russian "Eastern Force." The crossing of the Ya-lu by the Japanese. The Battle of Chiu-lien-cheng (the Ya-lu).
Chapter VI.—Events from the Battle of Chiu-lien-cheng (the Ya-lu) till the date when communication with Port Arthur was cut off, May 14.
Chapter VII.—Events from the time Port Arthur was cut off until the Russians took the offensive southward to relieve that fortress, May 30.
Chapter VIII.—Events in the theatre of war during the first half of June, 1904, up to Battle of Wafangkou (Te-li-ssu), exclusive.
Appendices and Notes to Vol. II.

In Chapter I., the description of the sea coasts and the points likely to be selected by the Japanese for the landing of their Armies is of interest. Fusan in Southern Korea is mentioned as the easiest and safest point for a Japanese disembarkation. Admiral Alexeiev, however, considered that a Japanese landing might be effected as far up the coast as Chemulpo. North

* Vol. I., Part 2, was reviewed in *The Army Review* of July, 1911, p. 189.

† All the dates in the French translation are given in the old and new style, thus:—March 15/28.

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of that port the landing of any important force in the presence of the Russian fleet was, in his opinion, impossible.

These opinions were based on the assumption that the Russian Fleet would display due activity at the outset of the war, whereas its complete inactivity permitted the Japanese to make Chemulpo their principal landing place at first and to change it later on to Tsinampo when the ice melted.

The chapter also contains a description of the roads and resources of the theatre and concludes with the admission that, though the Russian troops had occupied Southern Manchuria since 1898 and, in the Boxer insurrection of 1900-1, had traversed it in all directions, they had not succeeded, to the same extent as had the Japanese, in appreciating its possibilities and drawbacks from the point of view of military operations.

Chapter II. commences with a list of the Russian units in Siberia—from the Trans-Baikal to the Pacific—and their stations on February 10, when mobilization was ordered. The arrangements for the selection and the despatch of reinforcements from European Russia are then described.

As the Russians had taken no steps, previously to the outbreak of war, to organize an intelligence service in Japan and Korea, the Staffs both of the Viceroy and of the Army of Manchuria were dependent, for information regarding the Japanese, mainly on popular rumours.

The conclusions of the chapter are :—

(i.). The Russian forces in Siberia were small and reinforcements could be sent only in driblets.

(ii.). The disasters to the Fleet at the opening of hostilities complicated the task of the land forces.

(iii.). China's attitude being doubtful, it was necessary to keep a sharp lookout towards the west.

(iv.). The complete absence of information regarding the enemy further increased the difficulties of the Russian commanders.

Chapter III. begins with a statement of the dates of the arrival of Russian reinforcements in South Manchuria.

The next few pages, 46–52, are devoted to that part of the information regarding the enemy which seemed worthy of credence. The first such information was brought by the Russian attachés from Tokyo, who landed at Shanghai on February 17. Their information is compared with the facts as ascertained later, and is characterized as being far from the truth.

Other information from various sources is then given at some length, with the concluding remark that, at the end of March, the enemy's future plan of operations was for the Russians a complete enigma.

Pages 54–76 set forth the exchange of views between the Viceroy, General Kuropatkin and General Linevich on the proposed plans of operations, the result of which was that, after due provision had been made for the defence of Port Arthur, the Littoral Province, Vladivostok and Nikolaevsk, the Army of Manchuria was grouped in the following manner : the main body in the vicinity of Liao-yang, the Southern Advanced Guard watching the west coast of the Liao-tung peninsula from Ying-Kou to Hsiung-yao-cheng* with its reserve at Hai-cheng, the Eastern Advanced Guard (afterwards known as the Eastern Force) pushed forward to the Ya-lu and covered by General Mishchenko's cavalry in Korea.

After a description of the composition, condition and tasks of the Southern Advanced Guard and the Eastern Force, there follows an account of General Mishchenko's cavalry operations in Korea, and the information collected by him regarding the Japanese advance towards the Ya-lu.

The chapter concludes with a reference to a telegram despatched to the Minister of War on March 19 by the Viceroy's Chief of the Staff, who expressed the opinion that by April 14 the situation would be altogether favourable, and that it would then be possible for the Russian forces, acting on interior lines, to develop a decided superiority at any selected point. The comment on this view is that as the Army of Manchuria, owing to the state of its administrative

* The spelling of the names of places and individuals adopted in this review is in accordance with the Official History of the Russo-Japanese War, prepared by the Committee of Imperial Defence, and not with the French translation of the Russian Official History.

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services, was dependent on local resources and its far-away base in European Russia, it could not be considered capable of operating on interior lines, where the principal chance of success lies in the mobility of the troops.

The opening pages of Chapter IV. (pp. 117—139) are of special interest. They depict the difficulties of the commander of an Army which has to watch a long line of coast on which there are to be found many points suitable for an enemy, possessing command of the sea, to disembark his forces. These difficulties were intensified by the utter absence of reliable information regarding the movements and intentions of the Japanese, and by the divergence of views held by General Kuropatkin and the Viceroy, which had to be settled by a reference to the Emperor.

After April 24, the date of the arrival from Europe of the last of the 3rd battalions destined for the East Siberian Rifle Regiments, the influx of troops into the zone of concentration in Southern Manchuria practically ceased till the middle of May.

This was the result of the Viceroy's fears that a Japanese force of 36—48 battalions with mountain artillery and pack transport might land in the neighbourhood of Possiet Bay and operate thence towards Kirin or Ninguta—Harbin.

To meet this possibility, it was decided, in spite of General Kuropatkin's protests, but with the sanction of the Emperor, to retain at Harbin the 1st Siberian Infantry Division, which was the next reinforcement on its way to the Army of Manchuria.

This chapter also contains General Kuropatkin's report to the Emperor on his inspection of the troops which he completed by April 19. He drew attention to the numerical weakness of certain units and to the unsuitability of the vehicles of the trains, since the majority of troops coming from Europe had brought with them heavy four-wheeled vehicles useless in the mountains and during the rains.

On April 16, the question of the general plan of action was submitted to a committee consisting of the heads of the various departments of the Staff. This committee formulated six plans of operations which they conceived that the Japanese might adopt. None of the plans suggested had much resemblance to that which the Japanese actually followed.

Further disasters to the Russian fleet and the Viceroy's visit to Port Arthur had by this time called attention to the fact that the fortress itself with the remnants of the fleet in its harbour might become the object of a Japanese attack. The Viceroy, therefore, urged that the Army of Manchuria should be ready to lend its aid to the fortress. The result was that, by the end of April, Kuropatkin found himself charged with a triple mission, firstly to hold back the Japanese on the Ya-lu and the Fen-shui Ling range; secondly to guard the coasts of the Gulf of Liao-tung; and thirdly in case of necessity to come to the aid of Port Arthur.

His relief was great when he heard later on (April 28), that the Japanese were moving to cross the Ya-lu, since he accepted this fact as an important indication that their main forces would follow from the same quarter. The fears for the safety of Port Arthur and Vladivostok would thus be lessened, and the necessity for the extreme dispersion of the troops would cease, not in South Manchuria only, but in the whole theatre of operations.

It was not only on the question of the troops to be sent to succour the fortress that there was a divergence of views between the Viceroy and Kuropatkin. While the latter attached but little importance to the defensive value of the Ya-lu, and suggested the advisability of retiring the Army on Liao-yang, the Viceroy was in favour of offering a solid resistance to any attempt of the Japanese to cross the above-named river. This disagreement led to the Viceroy's request to be relieved, which however was not acceded to by the Emperor.

Pages 138—180 deal with the composition, distribution, tasks and operations of the three main portions of the Field Army of Manchuria, as already defined in pages 54—76.

On April 24 General Kuropatkin impressed on General Zasulitch, who commanded the Eastern Force, that his mission was to oppose the enemy with firmness but also with prudence, bearing in mind that he was not posted on the Ya-lu for the purpose of engaging in a decisive battle with an enemy of superior strength.

Chapter V. describes the events of the week preceding the Battle of Chiu-lien-cheng (the Ya-lu), and the battle itself.

The general conclusions (page 260) are as follows:—At first the accounts derived from Russian sources tended to attribute the Russian defeat to the turning movement of the 12th Japanese Division and to the insufficient resistance offered by the 22nd East Siberian Rifle Regiment. Information from other (foreign) sources, which became available at a later date, throws a different light on the affair. The turning movement of the 12th Japanese Division

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had in fact no decisive influence, as it was the operations of the Japanese Guard and 2nd Divisions which caused the Russians to evacuate the river banks from Chiu-lien-cheng to Po-te-tien-tzu. Similarly it was the attacks of fractions of the Guard and the Reserve and, to a limited extent only, those of the 12th Division which broke the Russian resistance on the rearguard position. With regard to the 22nd East Siberian Rifle Regiment, that corps did not evacuate the Po-te-tien-tzu position till after the 12th East Siberian Rifle Regiment had already abandoned that of Chiu-lien-cheng. By that time the 22nd was already hard pressed by the enemy in greatly superior force. In its retirement from Po-te-tien-tzu on Ching-kou it drew away after it the whole of the 12th Japanese Division and thus greatly delayed the completion of the latter's turning movement, which was to bring them on the Russian rear. Though there was an excellent field of fire for the Russian infantry, and the enemy presented a good target while crossing the sands and fords of the Ai Ho, the losses sustained by the Japanese were less than was expected by themselves and by the Russians. The poor marksmanship of the Russian riflemen, which let the Japanese off so easily, is attributed to the faulty construction of the fire trenches, which were deficient of head cover and offered a good mark for the Japanese guns.

Chapter VI.—In this and the two remaining chapters of the volume, the following general plan of treatment is followed. Firstly, the increase of the Russian Field Army by reinforcements is traced. The information regarding the enemy is then given, and lastly the views, plans and operations of the Russian commanders. The sequence indicates how completely the initiative lay with the Japanese.

In pp. 273–280 we have the exchange of views between the Emperor, the Viceroy and General Kuropatkin on the subject of plans to meet the new situation resulting from the Battle of Chiu-lien-cheng (the Ya-lu).

This exchange of views and the news of the disembarkation of the 2nd Japanese Army near Pi-tzu-wo led to the decision to concentrate the Russian Field Army with the least possible delay and to the withdrawal of the 1st Siberian Corps to the zone Hai-cheng—Liao-yang.

The history of events in this chapter commences with the narrative of the landing of the 2nd Japanese Army south-west of Pi-tzu-wo, the occupation of Pu-lan-tien on the railway by the Japanese on May 12, and the consequent cessation of Russian communication with Port Arthur.

Pages 308—330 deal with the Eastern Force and its withdrawal behind the Fen-shui Ling range. The opinion is expressed that if the Japanese First Army had decided or been able to undertake a rapid and energetic offensive it is probable that the Eastern Force would have failed to effect its retreat with all its transport and that the Japanese might have reached the cols close on its heels.

The remainder of the chapter deals mainly with the reconnaissance work of the Russian cavalry detachments.

Chapter VII. also is of special interest to British officers as illustrating the manner in which the Japanese command of the sea influenced the strategy of the Russian Commander-in-Chief and affected the land operations.

Pages 370 to 398 give the correspondence between the Emperor, the Viceroy and General Kuropatkin regarding the situation and plans to meet it.

General Kuropatkin was chiefly concerned with the consideration that the Japanese command of the sea enabled their forces to threaten his communications in the neighbourhood of Kai-ping or Ying-kou. Moreover he had formed the opinion that his Army needed additional reinforcements owing to the disasters which had overtaken the Russian fleet, to the ill-success of his troops on the Ya-lu river, and to the inferiority of his reserve units in respect of officers, artillery and train. Accordingly, on May 16, he asked the War Minister to send him two additional Army Corps provided wi h artillery of the latest pattern. Meanwhile he set his Staff to work out a scheme for assuming the offensive, not by an advance to the aid of Port Arthur, but by a movement to meet the enemy in case they should disembark in the neighbourhood of Kai-ping and Ying-kou.

The possibilities of Japanese sea power presented themselves to the Viceroy and his Staff in another light. They considered that the departure of the 3rd* Army from Japan and the possibility of a new disembarkation on the portion of the coast between Ta-ku-shan and Pi-tzu-wo which was not watched by the Russians, admitted of the supposition that the

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enemy's principal effort would be directed against Port Arthur. On this account they favoured an expedition into the Kwan-tung, *i.e.*, towards Port Arthur.

With this end in view the Viceroy formulated in a letter to Kuropatkin, dated May 21, two alternative plans.

General Kuropatkin commented on these plans as follows in his journal, dated May 24 :— "The Viceroy considers that the moment has arrived for the Army to advance either towards the Ya-lu or to the aid of Port Arthur This advice is given when it is not yet known where the Japanese 3rd* Army will disembark. Truly our strategy is rash : we have already compromised the Fleet, now it is the turn of the Army." His Staff reminded him that the rainy season would commence at the beginning of July and would render uncertain the movement of field artillery and wheeled transport, while they had not sufficient pack animals to assure supplies for the Army and only possessed seven mountain guns.

At this juncture also General Mishchenko reported, on May 22, the commencement of a Japanese disembarkation at Ta-ku-shan, which General Kuropatkin held to indicate the enemy's intention to choose the direction of Hsiu-yen—Hai-cheng for his main operations.

On May 27 General Kuropatkin wrote to the Viceroy to the effect that he was opposed to both his plans as entailing a hazardous dispersion of the Russian forces, and gave his reasons.

On the same day, the Viceroy and General Kuropatkin met at Mukden and agreed to refer to the Emperor for a decision as to whether an advance should be made to aid Port Arthur. News of the capture of the Chin-chou position by the Japanese was received on May 29 and strengthened the Viceroy's conviction that the enemy's principal effort would be directed against Port Arthur. He brought out this point in his telegram to the Emperor of the 29th, while, on the other hand, General Kuropatkin telegraphed his objections to the War Minister for submission to the Emperor. That the War Minister's views were not in accordance with those of General Kuropatkin is evident from the notes made by him later on, after the Battle of Wafangkou (Tel-li-ssu), on the copy which had been forwarded him of Kuropatkin's letter of May 27 to the Viceroy (*vide* Annexe 29).

On May 30, the Emperor telegraphed to the Viceroy :—"I share your views, as set out in your telegram of May 29." The Viceroy apparently read this sentence as a formal approval of the assumption of the offensive towards Port Arthur, as he at once telegraphed to General Kuropatkin to that effect, urging immediate action and the despatch if possible of a force of four divisions.

The remainder of the chapter (pp. 398—436) deals with the disposition of the Russian forces on May 16, the measures taken towards the end of May to reinforce the Southern Advanced Guard against a possible Japanese disembarkation about Kai-ping and the steps taken later on to stiffen both the Eastern Force on the Fen-shui Ling range and the Southern Advanced Guard with a view to a possible advance towards Port Arthur. The cavalry reconnaissances which were taking place meanwhile are also described.

Chapter VIII.—At pages 419 to 453 will be found the text of the War Minister's telegram to the Army Commander, dated June 1, and the despatches, dated Port Arthur, May 26 and 28, from General Stessel, which reached General Kuropatkin on May 31. The former document, after a review of the situation, urged the necessity for energetic measures to resist the Japanese and succour Port Arthur, provided that operations undertaken to these ends were conducted so that the Russian forces at the decisive point were sufficient to ensure success without exposing the troops to local defeats. It was further pointed out that the decision as to the direction and time of the effort and the allotment of troops must be with the commander on the spot. General Stessel's despatches, which were to become an important factor in the decision, reported the action at Chin-chou and the subsequent evacuation of Dalny and Ta-lien-wan. Port Arthur held an "extremely limited" quantity of projectiles and meat for at most three months. General Stessel was of opinion that it was against Port Arthur that the enemy's principal effort was being directed and urged that once his force was completely shut up in Port Arthur he would no longer be able to act in concert with a relieving force by attacking the position of Chin-chou. The relieving force must therefore be despatched immediately and be a strong one, at least three infantry and one cavalry divisions.

In his reply to Stessel, General Kuropatkin promised to do his best to aid Port Arthur, but added, "What you require is assistance and not that the Army of Manchuria should be defeated in detail."

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The Viceroy's opinion as to the critical situation of Port Arthur and the urgency of an immediate advance to its succour was confirmed by General Stessel's despatches, and he addressed a communication in that sense to the Emperor, dated June 4.

Meanwhile, the 1st East Siberian Division was being moved forward by rail from Kai-ping, and by June 6 was assembled at Wafangkou (Tel-li-ssu).

On June 4 the Viceroy received a despatch from the Emperor to the effect that the fate of Port Arthur caused him much concern, and that it was necessary to take more decisive measures to draw the Japanese troops away from it. General Kuropatkin was to be made to understand that the Emperor held him responsible for the fate of Port Arthur.

This despatch the Viceroy repeated word for word to General Kuropatkin "for information and action," and on June 6 he sent him in addition formal instructions in his capacity of "Commander-in-Chief of the Armies" to assume the offensive at once to relieve Port Arthur.

On the same day and in accordance with the Viceroy's instructions as given above, General Kuropatkin warned General Stakelberg that an energetic and prompt assumption of the offensive in the direction of Port Arthur by the 1st Siberian Corps, reinforced by the 2nd Brigade of the 35th Infantry Division, had been definitely decided upon. The defence of the sea-coast from Hsiung-yao-cheng to Ying-kou and the guarding of the routes from Hsiu-yen towards Hai-cheng—Kai-ping were allotted to Levestam's detachment and the 3rd Division of Siberian Infantry which was arriving by successive echelons. These troops were grouped under the command of General Zarubaiev.

On the 7th General Kuropatkin notified these arrangements to the Viceroy, adding the strength of each of the forces.

The Viceroy on June 10 objected that the forces detailed were insufficient for the task.

This evoked from General Kuropatkin two letters in reply giving his views generally on the course of operations so far, and calling special attention to the recent radical change in the Viceroy's views regarding Port Arthur's powers of resistance; and to the fact that owing to the early misfortunes of their Fleet and Army the Russian authorities had passed from an exaggerated contempt for Japan to an excessive estimate of her forces and their value. He also pointed out the bad moral effect that would result if the fears of its chief regarding Port Arthur were communicated to his troops. To operate towards Port Arthur with 48 battalions and to leave only 62 to defend the Fen-shui Ling range would not be acting in accordance with the general plan of operations approved by the Emperor.

In acknowledging these letters the Viceroy intimated his opinion that it was inopportune in time of war to continue correspondence of a polemical character, and stated that he would again refer to the Emperor.

On June 10, news arrived that Hsiu-yen had been occupied by the Japanese. This movement was held by Kuropatkin and his Staff to indicate an effort of the 1st Japanese Army against the communications of any Russian force that might advance southwards.

Three days later—on June 13—news was received that a considerable Japanese force was advancing northwards from Pu-lan-tien. At that moment 20 battalions, 19 squadrons, and numerous artillery of the 1st Siberian Corps were at Wafangkou (Te-li-ssu) and Wa-fang-tien. Simonov's advanced guard at the latter place was ordered to avoid a serious engagement, and, if necessary, to retire on Te-li-ssu where a defensive position was being prepared. Also the 34th and 35th East Siberian Regiments were ordered by rail to Te-li-ssu.

Thus the 2nd Japanese Army anticipated General Stakelberg's force in the assumption of the offensive with the result that a battle was fought at Wafangkou (Te-li-ssu), the account of which will be found in Part II. of this volume.

Pages 477—501 give an account of the operations which took place on the southern front between May 29 and June 12. Among the most important were General Akiyama's reconnaissance and the resulting combats at Te-li-ssu on May 30 and June 3. This reconnaissance was intended by General Oku to cover his movement on Chin-chou with a view to securing Ta-lien-wan and Dalny as bases for his Army and that destined for the Siege of Port Arthur. When it became evident to the Japanese General Staff, about June 6, that a Russian advance South towards Port Arthur was actually intended, they issued orders to the 10th Division and the 1st Army to assume the offensive so as to force the enemy to abandon his intention of reinforcing the 1st Siberian Corps. The fleet also co-operated, by a feint of disembarking troops near Hsiung-yao-cheng on June 7 and 8.

Pages 501 to 517 describe the operations of Mishchenko's detachment and the Japanese

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offensive towards Hsiu-yen, which took place while Stakelberg's force was being moved southwards. The information about the Japanese movements and intentions gained by the Russian cavalry was meagre and misleading, and General Kuropatkin made the following note on one of Mishchenko's reports: "It is useless for our cavalry to engage in encounter combats with their infantry." On June 8 the Japanese under General Asada drove Mishchenko's force out of Hsiu-yen and occupied it.

On June 11 General Kuropatkin instructed General Mishchenko to move slightly southward to discover whether any Japanese movement was in progress from Hsiu-yen in the direction of Kai-ping, through which were moving the troops destined for the southern advance.

Pages 517 to 567 deal with the Eastern Force and the various cavalry detachments holding the line of the Fen-shui Ling and guarding the approaches to Mukden, and the operations in the direction of Hsi-mu-cheng (Saimatsu). The first expedition to Hsi-mu-cheng which reached that town on June 1 showed how little prepared as yet were the Russian troops for operations in the mountain districts even with small detachments with their trains reduced to a minimum. It became evident that more energetic measures and some reinforcements were needed in this quarter and General Keller, by order of the Commander-in-Chief, prepared a plan for the assumption of the offensive towards Feng-huang-cheng by the Eastern Force as soon as reinforcements arrived.

The volume concludes with an interesting letter, dated June 13, from General Sakharov, the War Minister, to General Kuropatkin. The former considered that events in the theatre of operations during the first half of June had not justified the opinions of the Commander-in-Chief regarding the possible attack of his Army by two Japanese Armies totalling about 100 battalions. On the contrary Kuroki, after his success on the Ya-lu and advance to Feng-huang-cheng, had stopped at the latter point, which argued his comparative numerical weakness. It seemed that Kuroki was trying to attract Kuropatkin's attention so that the other Japanese forces destined to act against Port Arthur might disembark unhindered. With this end in view Kuroki had undertaken a series of small and by no means serious operations with success, as the Army of Manchuria had maintained a waiting attitude in the face of an inferior force, while other Japanese Armies had disembarked on the Liao-tung Peninsula, gained an important success at Chin-chou and cut off Port Arthur. It was to be hoped that the latter place could hold out till relieved in some way or other.

Further the Emperor was unable to understand why the Russian cavalry, though superior in numbers, had achieved nothing, not even information more or less positive as to the distribution of the enemy's forces.

As regards the additional two Army Corps asked for by the Commander-in-Chief on May 16, the War Minister gave his reasons for considering the moment had not arrived for their despatch. The letter concluded with a reminder that the Emperor regarded the situation with some alarm since the possible fall of Port Arthur would shake Russian prestige. Consequently if, as the Commander-in-Chief surmised, the war was going to last 18 months, it was most necessary that the Japanese successes of the last four months should come to an end, and the rest of the war should be characterized by successes of the Russian forces, which were now strong enough to show their activity in a decisive form.

The English reader will encounter some difficulty in using the maps accompanying the volume, partly because of the French spelling of the place-names, partly because the spelling of the latter is not always similar to that in the text, and partly because the blocks and lines representing troops and their movements often obscure the detail of the map.

The notes in the French translation, each referred to by a number in the text, are not identical with those in the Russian original. Those in the French translation are apparently more up to date.

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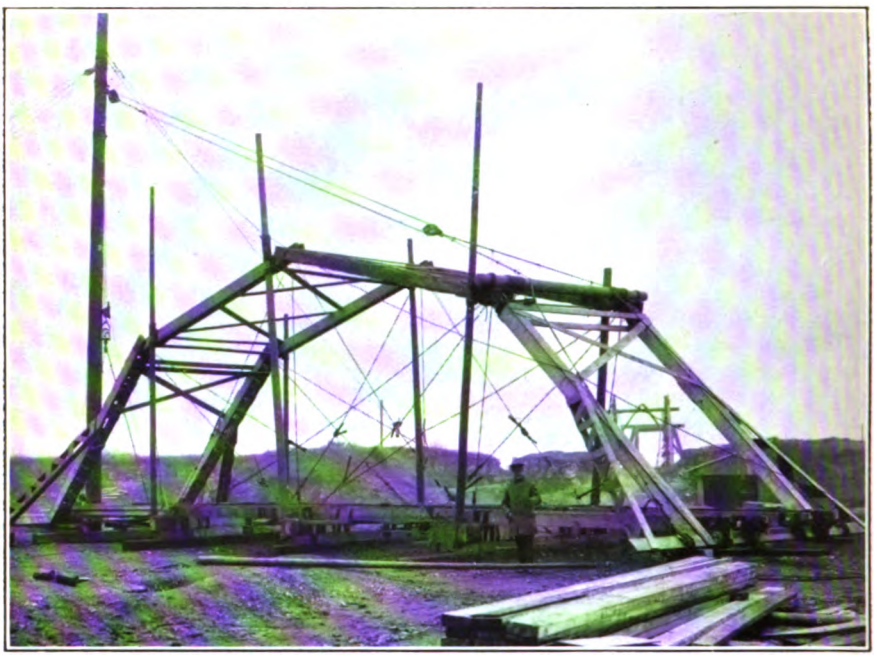
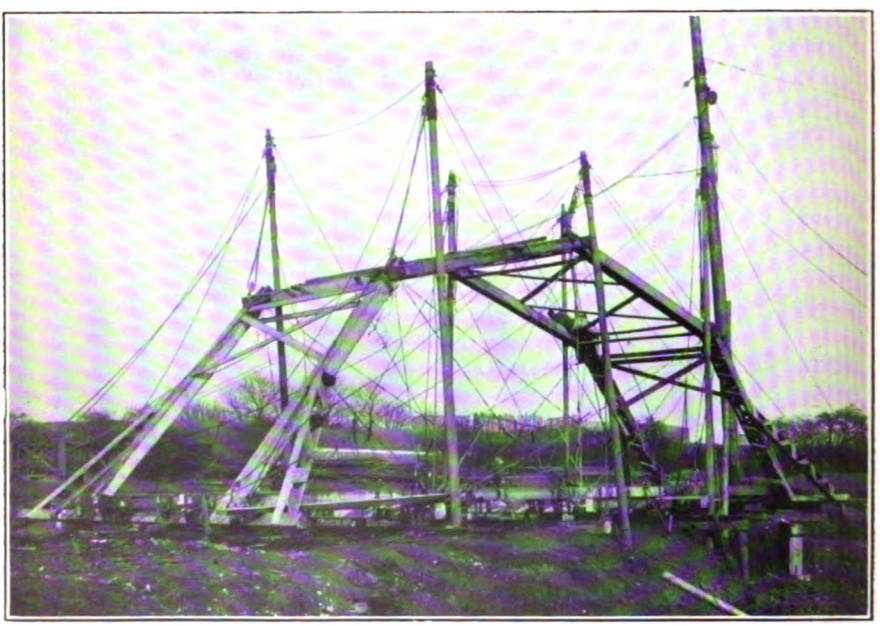
FIELD GIRDER BRIDGES.





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FIELD GIRDER BRIDGES.

By MAJOR G. E. SMITH, C.M.G., R.E.

IN an article in the *R.E. Journal* of July, 1912, Major McClintock, D.S.O., describes an adaptation of the "Tarron" girder which he calls the "Bangalore" girder. The Commandant, S.M.E., directed me to experiment with such a bridge, which I now propose to describe.

Careful readers of the *Journal* will have noticed that Major McClintock has further developed his design and published his results in the January number, and it will be noticed that the design is considerably improved. My solution differs in various respects, having been arrived at previous to the publication of the second article. My problem was to design a girder of 64 ft. span to take infantry crowded in fours, and I found that by putting in a few extra road-bearers I could also deal with concentrated loads up to 75 cwt.

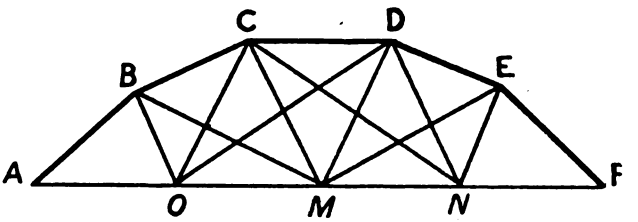

FIG. 1.—"*Bangalore Girder.*"

In the Bangalore girder it will be noticed that if loaded at O only, the girder, which is hinged at BCDEF, is unstable unless the weight of the roadway is sufficient to prevent E from rising with the thrust. Accordingly, whilst retaining three suspended transoms I used a four-sided funicular polygon and suspended each transom from all the angles of it.

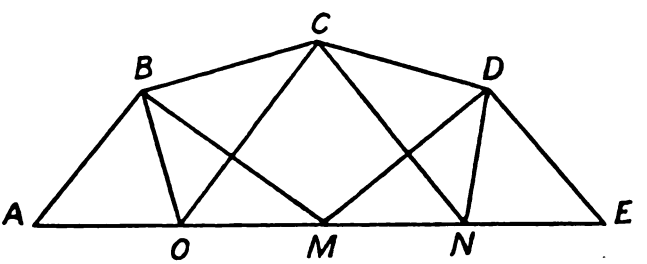

FIG. 2.—*Tarron Girder as constructed at S.M.E.*

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Exactly what cross-bracing was put in was not clear in the July article; if wires were used they were so fine as not to be visible in the photographs. In any case the shore frames cannot have been braced as the braces would have interfered with the headroom. The lateral stiffness appears to have depended on the pin joints. I cross-braced the frames BC, CD in an ordinary way with light planks whilst the shore frames AB and DE were cross-braced at the top and stiffened below by using rather a heavy shore transom prolonged to form an outrigger as in *Fig.* 3.

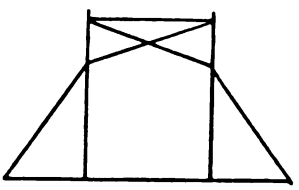

FIG. 3.—*Shore Frames.*

It should be noticed that when using very light cross-bracing, it is most important to have the frames accurately squared so that the compression members may be in vertical planes.

I found after building the bridge that the roadway swung to and fro when infantry crossed it, so I afterwards added light cross-bracing under the roadway, which made the bridge laterally very stiff.

In McClintock's bridge the thrust of the joints was taken by iron pins in wooden holes. With my heavier load the compression members would have crushed and split, so I shod each compression member with thin iron plate to take shear off my pins.

In order to save weight I found it advisable to make all the compression members double. The narrower ones were stiffened with cover boards whilst the wider ones had cross-bracing of light boarding. Incidentally this had the advantage of permitting the main ties to be fastened symmetrically to the centre part of the pins.

I had anticipated considerable difficulty in correctly adjusting the numerous ties, but in practice I found that, by making each tie with two parts and adjusting by Spanish windlass, no difficulty resulted.

In erecting the girder my procedure was somewhat different. Each frame was cross-braced separately, each pin joint as soon as connected was hoisted by a pair of derricks and adjusted by them. These derricks then became suitable struts for stiffening the bridge whilst swinging. An extra spar was required to give the sling of the outer end a fair lead without bringing pressure on the light cross-bracing.

This bridge actually took 1,090 man-hours to erect, but I do not think that a field company at war strength could construct it in less than 20 hours of work. The pins are too heavy to forge on a field

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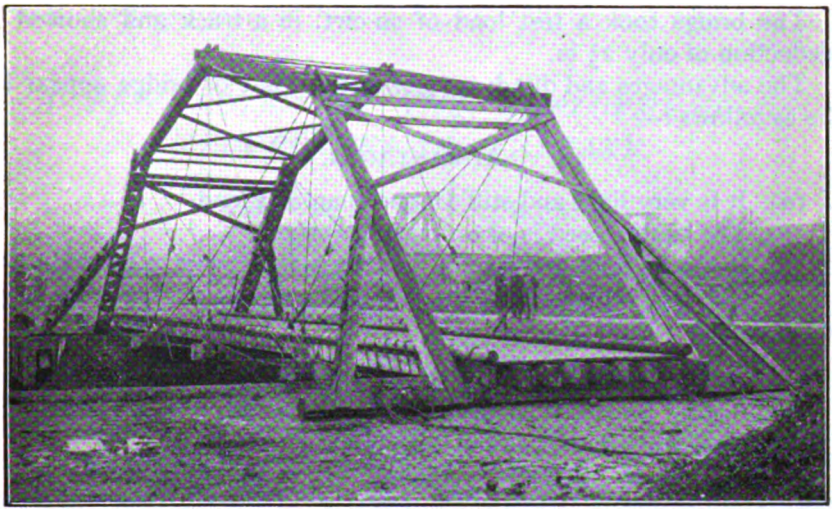

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forge, and hoisting gear beyond that carried by a field company is required for swinging.

The weight of bridge at swinging was 6 tons, whilst the weight completed was 6 tons 16 cwt.

The bridge took a test load of 90 cwt. in a truck and showed a deflection of only $2\frac{1}{2}$ in.

The advantages and disadvantages of this kind of bridge appear to be as follows :—

ADVANTAGES.

(*a*). It is very light and stiff for the span and load.

(*b*). The timber used is of ordinary scantlings.

(*c*). It can be built and swung without crossing gap to be bridged.

(*d*). Being a complete girder no anchorages are required after construction.

DISADVANTAGES.

(*a*). Special ironwork has to be carried or made.

(*b*). The stresses may be indeterminate.

(*c*). The extra stiffening required for swinging involves extra labour and materials.

(*d*). The frames require very accurate construction.

(*e*). The cross-bracing cannot satisfactorily be calculated, for deforming forces sideways would depend chiefly on any inaccuracy of construction and would not merely depend on wind.

(*f*). A very heavy spar is required for the derrick for swinging.

(*g*). The bracing of end frames cannot be completely satisfactory as headroom must be allowed.

(*h*). For a large bridge the frames are too heavy to be readily portable.

(*i*). Stiffness is not necessarily an advantage in field bridges, for no warning is given before failure.

In practice I should never construct a bridge of this kind unless the gap were very deep. Where 3-in. steel rope is available a tension bridge would usually be preferable. I should only construct this type if anchorages were impracticable, and the gap very troublesome to cross. I have to thank Capt. Grove for much help with this bridge.

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A FEW NOTES ON THE EMPLOYMENT OF AEROPLANES IN WARFARE.

By Capt. A. G. Fox, R.F.C.

These notes do not profess to be in any way complete but are a few lessons learnt from last year's manœuvres and elsewhere.

Strategical Reconnaissance.

At the commencement of a campaign it is imperative that the G.O.C. be furnished with early information as to the position and size of the enemy's columns. At present the independent cavalry is pushed forward to obtain this, but before it can do so it must break through the enemy's protective troops, and will in all probability have to dispose of the hostile cavalry operating in the zone separating the two armies ; and so, unless it is exceedingly strong and prepared to do a lot of fighting, all it can do is to discover the contour of his covering troops. This is the time when the employment of aeroplanes will be of the utmost value ; they can go straight out and locate the main bodies of the enemy without being stopped by his protective troops and without troubling about his cavalry, except to locate it. This will leave the independent cavalry free to perform any special tasks assigned to it or it may even be dispensed with to a large extent leaving more free for protective duties. It will also be of great advantage to the strategical concentration as the preparation of ships to carry a large number of horses takes time. So aeroplanes will speed up the initial stages of warfare.

For this purpose a squadron of aeroplanes with a large radius of action will be required. This will be best furnished by a squadron of fast single-seater monoplanes, which will have to trust entirely to their speed to escape from the hostile aircraft.

If a force of independent cavalry is still employed, a squadron of aeroplanes will be of considerable assistance to it. Their chief duty will be to locate the hostile cavalry's bivouacs each evening. During the day it is doubtful whether they will be of much use, as they will probably not be able to get any information that they may obtain back into the hands of the commander before the situation has developed so much as to render the information of very little value to him.

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For this purpose a squadron of two-seater monoplanes would probably be the most suitable, as they must be of a type easily transported by road, so that in the event of the weather being too bad for them to fly they can keep up with the cavalry by road.

TACTICAL RECONNAISSANCE.

(1). *The Reconnaissance of a Position.*—Aeroplanes will be of considerable assistance in this, as they will be able to find out the extent of the position and also to locate the enemy's general reserve and cavalry; two things which it is difficult to locate by other means. But they are not suited to the actual reconnaissance of the ground, as it is very difficult to tell from up above what points on the ground are mutually visible; but even in this a highly trained observer might be of considerable assistance.

(2). *The Attack of a Position.*—During the actual attack the movements of troops in the firing line will be of a too detailed nature to lend themselves greatly to aerial observation, but the aeroplanes will be able to note the general trend of these movements and also to obtain early information as to any moves of the hostile general reserve and cavalry, early information on which points is of the greatest value to the G.O.C. as it enables him to know when and where to expect a counter-attack. They will also, owing to movements of transport to the rear, be able to tell him of any signs the enemy may show of weakening any part of his line or of retiring, and thus assist the G.O.C. in knowing when and where to throw in his own reserves. If the enemy is defeated they will be able to give invaluable information as to his lines of retreat, and so ensure the opposing cavalry being sent out in the right direction. There have been many instances in history where the want of this information has led to the cavalry being sent out in the wrong direction, and thus the fruits of the victory have been lost to the victors. At this time also the aeroplanes might be employed in dropping bombs. They would be able to fly quite low, and the moral effect of a few bombs dropped amongst the troops already partly demoralized by their defeat might conceivably greatly assist the cavalry in turning a retreat into a rout.

(3). *The Defence of a Position.*—In this the chief duty of the aeroplanes will be to locate the enemy's lines of advance, and to discover against which portions of the lines he is massing most troops, and thus prevent him delivering an unexpected decisive attack. They must also carefully watch the flanks of their side for any signs of an outflanking movement on the part of the enemy.

(4). *During a Contested Advance or Retreat.*—Here the times when the aeroplanes can be most usefully employed will be the evening and early morning. In the evening there usually comes a time when there is a lull in the fighting owing to the fatigue of the

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troops, and they start settling down in their positions for the night; then the aeroplanes must go up and locate these positions, and again they must go up in the early morning and catch the enemy as he moves out and discover the directions in which he is moving.

For all these duties, which I have classified under the heading of Tactical Reconnaissance, the best type of aeroplanes would be two-seater biplanes, provided that there is a sufficient supply of well-trained observers. It has now, I think, been fairly conclusively proved that, except in very bad weather, a good pilot alone will bring back quite as good information as a partly trained observer.

These machines do not require to be very fast, but as they will have to do many short trips, they should be able to climb rapidly and to land at a slow speed. They will have to trust to special fighting aircraft of their own side for their protection from the hostile aircraft. Possibly they might carry some form of light armament, but as, I think, their *rôle* should be strictly confined to reconnaissance this would probably only hamper them.

Organization.

At present the idea is to keep the aeroplanes as Army Troops under the C.-in-C. who will allot them to divisions as required, but considering the purposes for which I have suggested they may be used I think that the eventual organization may be somewhat as follows:—

(*a*). *Army Troops.*

2 squadrons fast single-seater monoplanes.

(*b*). *Cavalry Divisional Troops.*

1 squadron two-seater monoplanes.

(*c*). *Divisional Troops.*

6 squadrons two-seater biplanes.
6 squadrons fighting machines.
(One squadron of each per division).

Total—15 squadrons with the Field Army.

These numbers are taken with the strength of squadrons as at present, viz. 12 machines per squadron.

The total number of squadrons required would be considerably greater than this as the wastage of war in this arm will be very great indeed, and it will probably be necessary to send out complete fresh squadrons during the progress of the war to replace those first sent out.

In conclusion, I will put forward a few suggestions as to the influence that aircraft will have on the conduct of warfare in the near future, beyond which it is impossible even to surmise what will happen owing to the rapidity with which aircraft are developing.

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It appears that the whole conduct of war will be a much more deliberate art than it is at present. By deliberate art I do not mean that it will be slower, as, on the contrary, I think that it will be quicker, but that events will be more calculable and will be more accurately foreseen; in fact war will be less of an art and more of a science. The element of surprise will be removed almost entirely from it and battles of encounter should be things of the past.

The character of the advanced guard will be modified as its duties will be confined almost entirely to those of protection, the aeroplanes relieving it of nearly all its reconnaissance duties. A commander may also decide to use his advanced guard to start his battle. The advanced guard action will not be a sort of reconnaissance in force, but the first phase of the actual big fight, *i.e.* seizing tactical points, villages, etc.

It has often been said that aircraft will supersede cavalry, but I think that this idea is fallacious and that they will prove to be the cavalryman's greatest friend, as by relieving him of his reconnoitring duties they will leave him free to carry out his still more important *rôle*, that of co-operation with the other arms on the battlefield. And also in the future we shall not have so many instances of a victorious army being robbed of the fruits of its victory owing to the horses of the cavalry being too tired to take up the pursuit and prevent the enemy rallying and re-forming.

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PIVOTS IN DEFENCE; THEIR SIZE AND ORGANIZATION.

By DOLF.

Field Service Regulations, Part I., lays down (Sec. 107. 9) that "defensive positions will normally include a number of localities of special tactical importance," and that "the efforts of the defender will be directed in the first instance to occupying and securing these points." Here then is a definite principle on which the defence of a position or zone should be conducted. According to the *Manual of Field Engineering* (Sec. 50. 3), these localities may be commanding features of the ground, groups of substantial buildings and enclosures, or wooded knolls. It has been pointed out (*vide* "Natural *Points d'Appui*," *R.E. Journal*, February, 1913) that localities such as woods and villages, which are so to speak ready to hand, are better than those which have to be constructed for the purpose, such as a group of trenches on a hill. The following reasons were given; woods and villages are easily adapted for defence; abundant material for obstacles, etc., is usually available; they afford cover from the view and fire of the enemy and serve to screen the movements of reserves; and, perhaps most important of all, they give almost complete concealment from hostile aerial reconnaissance.

It cannot be expected, however, that natural *points d'appui* or pivots (to use the official nomenclature) of suitable size and situation will always be forthcoming. It seems clear then, that if this system is to be followed "natural" pivots may have to be enlarged, or entirely "artificial" ones constructed.

Thus the question arises as to what is the suitable size for a pivot; for if one has to be made to order, some idea as to this point is certainly necessary. Before going into this it may be well to recapitulate the objects and advantages of this system of defence. The objects may be said to be

(i.). To regain to a certain extent initiative presumably lost owing to defensive attitude: this is accomplished by occupying localities that are certain to attract the enemy to attack them.

(ii.). To preserve an offensive spirit in the defence by giving opportunities for counter-attack.

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(iii.). To economize the numbers required for defence by occupying only part of the front.

(iv.). To facilitate command and organization of the defence by the concentration of the defenders into nuclei.

(v.). To obtain full benefit from the power of modern firearms and the disconcerting effect on the enemy of flanking and cross fire.

Other advantages not included in the above may be said to be

(i.). The gain in *morale* due to an increased sense of security which results from the shape of the pivot, its internal organization, and the facilities for strengthening it.

(ii.). The mutual support of neighbouring pivots.

(iii.). The possibility of developing flanking fire from positions screened from the front.

(iv.). Ground can be used to the best advantage.

Almost the only disadvantage is the liability to concentrated hostile artillery fire. This can be lessened by avoiding overcrowding and making good cover.

To attain the objects and secure the advantages enumerated above, a pivot must be of sufficient size and suitable shape to give the necessary amount of fire to front and flanks; it should require for garrison a complete unit or an easily handled portion of one; it should be large enough to be comparatively invulnerable to artillery fire. These are not very definite data from which to fix the size of a pivot, but it is necessary to make the best of them.

The length of front required depends upon the amount of ground to be covered by fire. This is determined by the extent of field of fire to the front, and partially by the interval between neighbouring pivots; both these depend again on the nature of the ground both as regards shape and surface in so far as visibility is concerned. The amount of fire to a flank which is required, also depends upon the extent of field of fire in that direction. If the ground is open, it would seem desirable that the whole space intervening between two pivots should be under the "close" rifle fire of one or other; this would give 1,200 yards as a maximum interval; either pivot would then be able to sweep the front of the other with "effective" fire. Under these conditions each pivot would be responsible for 1,300 yards or so of front. The maximum garrison excluding local reserves for this frontage, calculated according to Sec. 108. 8, *Field Service Regulations*, I., would be 1,950 men, or two battalions.

The conditions assumed are, however, very favourable to defence; the ground is open and there are facilities for forming strong pivots; the method, as such, aims at holding certain portions of the line only, so that a larger proportion of the troops may be available for counter-attack. It seems therefore that a battalion would suffice for the

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garrison of a pivot in the conditions described. If the ground is such that the field of fire to front and flanks is more limited, the interval between pivots may have to be reduced. On the other hand, the enemy will be under fire for a shorter time and more rifles may be necessary to produce the required effect. Within certain limits these factors would neutralize each other and a battalion would remain theoretically the most suitable garrison. It is obvious that, when the field of fire to the flanks is very limited, smaller garrisons will suffice.

It may be said that such theoretical discussion has little practical value and that each case can only be dealt with on its merits. It is certain that each case must be dealt with on its merits, but previous theoretical discussion should facilitate this being done quickly and correctly.

In the defence of a position on this system, therefore, an estimate should first be made of the average garrison for a pivot demanded by the type of country. For ordinary European country, a battalion to a pivot seems a good basis to work on, if the necessity for modifications imposed by abnormal conditions is kept in mind. This, of course, applies to operations of the type contemplated in Secs. 107 and 108, Ch. VII., *Field Service Regulations*, Part I., that is stubborn defence by a considerable force.

Other conditions, as in the case of a protective detachment, may require a smaller force to hold a more extended line; the average pivot garrison would then be proportionately reduced.

"Natural" localities, or possible sites for artificial pivots, must next be examined. If the former are unsuitable as regards size or in other respects, it is for decision whether the advantage of concealment from air craft should outweigh other considerations, such as undue concentration and consequent liability to suffer from artillery fire; whether, in fact, the locality should be occupied as it stands, enlarged "artificially," or a fresh artificial pivot constructed on a more suitable site.

It may happen for strategical, or even tactical reasons, that there is no objection to the enemy discovering the position and that there will be no advantage in concealment from aircraft.

Concealment from the view of hostile troops on the ground is a different matter and should always be arranged for as far as possible.

In applying this system of defence to the ground there is a tendency to hold minor features or localities. This should be guarded against as it leads to the formation of a line of small posts. Such a line has few advantages over the old linear method and many disadvantages, especially as regards organization, compared with the system of large pivots.

There seems to be a certain amount of vagueness about the terms "pivot" and "post." Neither is defined in any training manual, except the former in its cavalry signification.

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Every defended locality is not likely to be a pivot in the original meaning of the word, but the term seems to be the official one for what the French call *points d'appui*, or what Major Swinton in his lecture at the R.A. Institution on February 16th, 1911, characterized aptly as "defensive blobs." The customary use of the word "post" implies something on a smaller scale, and it would perhaps be well if the distinction as to size were generally recognized. One could then say without fear of misunderstanding that, if the shape of the ground or tactical conditions demanded that a "pivot" should cover an area somewhat extended for its garrison, it could be occupied by holding "posts" at intervals connected by obstacles.

One of the advantages claimed for the pivot system was the improved facilities for the command and organization of the defence. This is due of course to the concentration of the defenders into well-defined localities, instead of their being distributed along the whole front. Communication (in both senses of the word) to the rear is much simplified.

The internal organization of the pivot must also be good, if full value is to be derived from the system.

The garrison of a pivot will usually consist of the firing line and supports, local reserves being kept outside for use in intervals, etc. No great measure of offensive action will therefore be expected from the pivot itself; and the proportion of the garrison in the firing line can for this reason be relatively high. Men so allotted to the front line beforehand will be of more use there than if hurried into position at the last moment; and, if suitable internal communications have been made, they can always be moved to reinforce a more threatened portion of the defences.

Screened communications are very important; these must be both lateral, along the front line, and radial, back to the centre, where headquarters, reserves, etc., will usually be located. The enemy should not be able to detect any movements in, or behind, the firing line. If time is available such communications should be made bullet proof.

The shape in plan of a pivot generally gives a fair indication of its suitability; if there is a great disproportion between its breadth and depth, there should at least be some good reason for it.

It is better, if tactical considerations permit, not to allot to a pivot a garrison which does not admit of a sound system of command and organization. A complete unit, a company or battalion, whose commander is known to all is obviously the best; two companies or two battalions are probably the worst, as the command of, say, a battalion by the colonel of another in addition to his own can never be a really satisfactory arrangement.

Within the pivot, the subdivision between units should correspond with tactical requirements; better results may be expected if, for

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instance, companies do not unnecessarily have to face both to front and flank, but can be given a definite tactical mission such as sweeping with fire the front of a neighbouring pivot.

A so-called "Keep" may be prepared to enable the garrison to continue to resist after they have become too weak to hold the original outer line, or so that, owing to changed tactical conditions, the pivot can be held with a reduced garrison. Each case must be considered on its merits; it will often be undesirable, and sometimes impossible, to make a "keep."

It is laid down in the *Manual of Field Engineering* (50. 3) that "pivots should be capable of all-round defence." It would seem that this should be interpreted to mean that the flanks should be brought well back, so that the defence would not be seriously affected by even the loss of a neighbouring pivot.

The inadvisability of doing anything which would assist the enemy to hold the pivot if he captured it, and the extra work which would be entailed by making defences actually facing to the rear, would as a rule counterbalance the advantage of being prepared for the somewhat unlikely contingency of an attack from that direction.

The *Plate* shows suggested organization for two such pivots in fairly typical country. It may serve to illustrate most of the points mentioned above. No. 1 is supposed to be the right flank pivot of a position occupied by a brigade. Both are liable to be exposed to artillery fire. Their extent is, however, such that they would not be greatly affected by it. No. 1 can develop plenty of fire to the exposed flank. It is perhaps a little weak in frontal fire; wing trenches A and B would be used to increase this if necessary.

The distance apart is in this case decided by the shape of the ground; the central interval works out at about 1,200 yards. A battalion would be a suitable garrison for each pivot, assuming of course that a stubborn defence is intended. This may appear excessive in the case of No. 2, but owing to the contour of the ground the defence of its left flank could not be assisted from the next pivot. In both cases "natural" cover is available; the hedges round the village are thick and high, and "East Wood" is a well-grown hazel copse with some large trees. Any clearings required would not be conspicuous as they are a common feature of such woods. There are good existing radial communications in No. 1, and the lane along the front of East Wood would serve for lateral communication in No. 2. Others would have to be made. The shape of No. 1 may be said to be suitable; No. 2 is somewhat broad for its depth, but this is dictated by the shape of the ground.

If desired, a "keep" could be arranged for in No. 1 Pivot in the area—"Parsonage Farm—St. Mary's Church School." It would be practically impossible to form one in No. 2. An entrenchment could of course be made in rear, say, in the neighbourhood of C, but it

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would have little connection tactically with the primary defence of the pivot.

As regards the occupation of such positions, the approximate sites of pivots would be given and the garrisons allotted by the brigade commander, working on results of reconnaissance carried out by or for him or by divisional or higher authority. The pivot commander would then be responsible for the detailed arrangements for which any report or sketch made by a reconnoitring officer would be most useful. To assist in the work some Sappers would no doubt be allotted if available. As we have only $\frac{2}{3}$rds of a Field Company to an Infantry Brigade, one section is all that can be expected for a pivot occupied by a battalion.

The R.E. officer should be the pivot commander's adviser as to the employment of the Sappers, and in all other technical points connected with the defence. These are outside the scope of this article which has dealt with purely tactical considerations; technical details are, however, so closely allied to what may be called tactics of ground, that there seems no doubt that all R.E. officers should be experts in the latter subject as well as in the former, especially as it is laid down in *Engineer Training* that the reconnaissance of the ground and proposals for its occupation may fall to the lot of Engineer officers.

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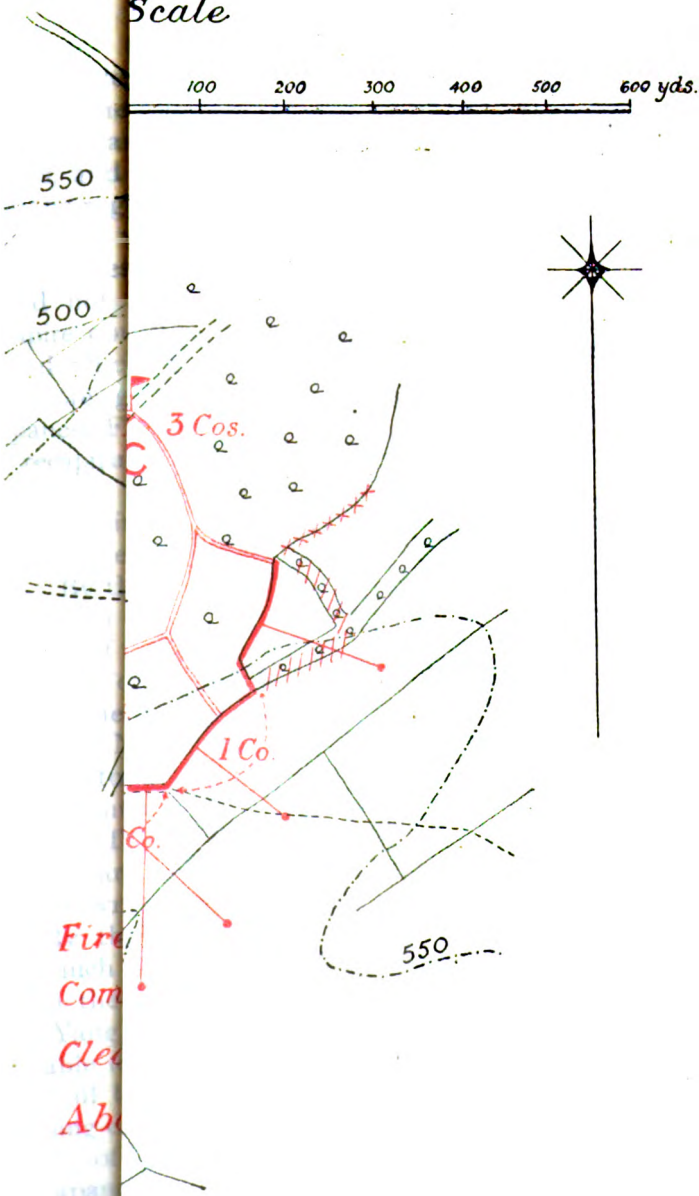
OTS IN DEFENCE.



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SOME NOTES ON THE ACTION OF THE JAPANESE FIRST ARMY AT LIAO-YANG.

By Lieut. C. R. Satterthwaite, R.E.

The Battle of Liao-Yang was the first of the three great battles on land in the Russo-Japanese War, and though in many respects indecisive—as there was no rout or disorganization of the Russian forces, and the Japanese losses exceeded those of the Russians—it may be regarded in some ways as the most momentous of the campaign. It was the first pitched battle between evenly matched forces of the West and East, and it effectually silenced those critics who could not believe it possible that the forces of the great Russian Empire could be seriously checked or defeated by those of a small island which had only awakened from mediævalism forty years before.

Before going into details of the great turning movement of the Japanese First Army which really decided the battle, it will be as well to recapitulate shortly the events of the campaign up to the date of the battle. War broke out in February, 1904, and the Japanese, organized in four armies, began to land in Manchuria, naval successes having given them for some time at least the local command of the sea. By the end of April General Kuroki's First Army had landed at Chemulpo and Chinnampo, concentrated at Wiju, and forced the passage of the Yalu. During May General Oku's Second, and General Nodzu's Fourth Armies landed at Pitzewo and Takushan respectively. Oku turned south and drove in the outer line of defence of Port Arthur at Nan Shan ; then turned north again and defeated a Russian attempt to relieve Port Arthur at Telissu, leaving the investment of Port Arthur to General Nogi's Third Army, which had only just landed. Thus Kuroki, Nodzu, and Oku were advancing in converging lines towards Liao-Yang, the ancient capital of Manchuria, where it was known that fortifications had been prepared, and where consequently the first great battle was expected to take place. Kuroki had much stubborn fighting at the Motienling Pass and at Anping, but in the last days of August all three armies were in touch before Liao-Yang, with practically the whole of General Kuropatkin's available forces before them.

It will be as well to consider the different objects before the two opposing commanders, as the effect of these is often apparent in their conduct of the battle. Marshal Oyama, the commander-in-chief of the Japanese Army, had a task which was fairly clear. He was operating relatively close to his base, while his opponents depended

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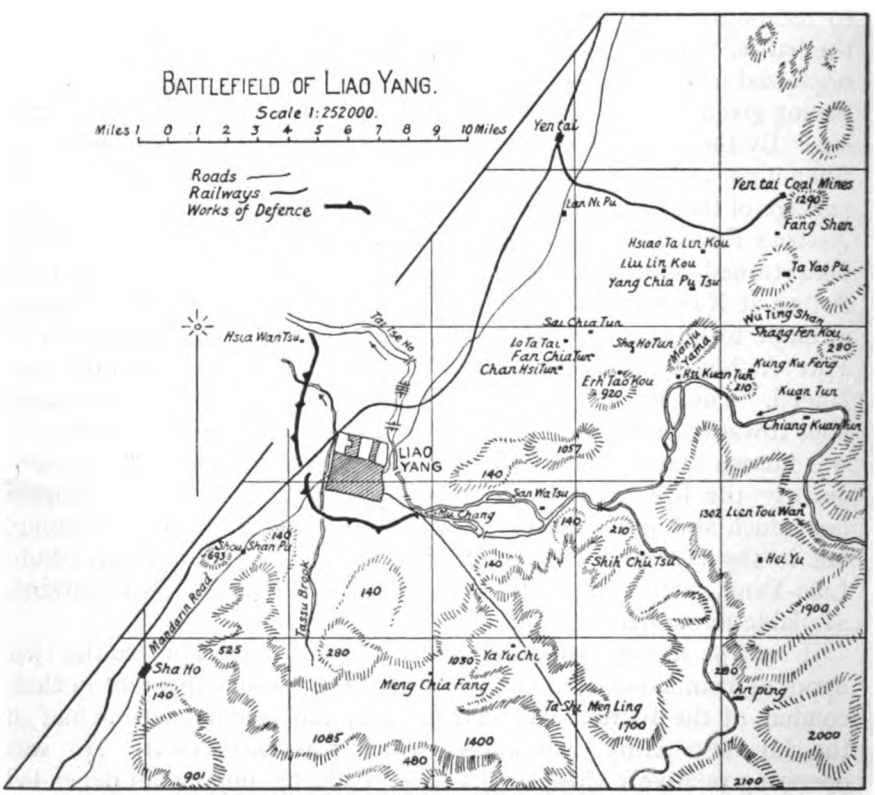
on 5,000 miles of single-line railway. Obviously he must strike quickly, overcome the Russian forces in Manchuria before they could be largely reinforced, and so if possible secure a favourable peace before the resources of his own country were exhausted. Strategical victories were of little use to him. The capture of Port Arthur might well have been a secondary consideration, but there were sentimental reasons for its investment, and its capture might be expected to add enormously to Japanese prestige.

Kuropatkin had a far more difficult task. He had continually to fight delaying actions, putting off battle till the railway could give him the force with which he hoped to overwhelm the Japanese and march to Tokio. His attitude is best described by the words attributed to him before the war: "After one month they will call me inactive; after two, incapable; after three, a traitor; after six, we shall see!" Russian plans were further complicated by the fact that great unrest prevailed at home, and it was urgently necessary to be able to report successes in the field, in order to distract the attention of the discontented peasants.

As will be seen from the map, the south and east of the theatre of war is mountainous. The hills are rugged and rise to a height of over



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2,000 ft. to the south and east, although nearer Liao-Yang few are even 1,000 ft. Most of the rivers are rapid but fordable. Roads are bad and unsuitable to any except the native carts. The Mandarin road, running along the railway from Port Arthur by Liao-Yang to Mukden, is the best, whilst fair roads connect Liao-Yang with Wiju and Takushan. The railway divides the hilly ground from the great Manchurian plain to the north-west, and has a branch north of Liao-Yang to the Yentai coal mines. The chief peculiarity of the country at the end of August was the giant millet, or kaoliang, which covered all the low country and much of the lower slopes of the hills to a height of 8 ft., and so formed a screen to hide advancing infantry, though hampering their movements to some extent.

The Manchurian climate in August is hot but healthy: some rain falls and roads are rendered difficult at times, but on the whole the season may be called good for campaigning. Daylight lasts from about 4.30 a.m. till 8 p.m.

The Japanese First Army under General Kuroki consisted of three divisions; the Guards under General Hasegawa, the 2nd Division under General Nishi, the 12th under General Inouye, and the Guard Kobi Brigade under General Umezawa. Each division consisted of two brigades, with a cavalry regiment of three squadrons, six 6-gun batteries and a battalion of engineers 750 strong with bridging train and telegraph company: each brigade contained two infantry regiments of three battalions each, 950 rifles per battalion. General Kuroki therefore had about 40,000 rifles and 120 guns, while the total Japanese force is generally estimated at about 130,000 men and 600 guns, though some authorities give the total as considerably greater. General Kuropatkin had about 150,000 men and 500 guns.

Realizing that Liao-Yang marked the certain point of concentration of the three Japanese armies, Kuropatkin had previously prepared a fortified position there. He hoped to be able to delay the Japanese advance by rear-guard actions till the end of September, by which time he expected to have a force collected in Liao-Yang with which he could with safety launch his great counter-stroke. However, the Japanese advance could not be checked, and he found himself forced back on his advanced position of defence on the 28th of August. This line, consisting of field redoubts and works, extended from Shou Shan Pu by Ya Yu Chi to Hsi Kwan Tun, with a gap in the middle where the Tassu brook crossed. His right flank, consequently, resting on a small hill near Shou Shan Pu, was in the air; his left, where his communications with Mukden were specially vulnerable to Kuroki's army, was well thrown back behind the Tai Tse Ho. His works were chiefly on the forward slopes of the foothills, commanded by the higher hills to the east and south, but very strong, while the Tai Tse Ho, 200 yards wide, and fordable in places only, with no bridges save

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in the close vicinity of Liao-Yang, was a formidable obstacle to the attacker. His second line, forming a bridgehead round the city, extended from Hsia Wan Tsu to Mu Chang, protecting six bridges between those limits. On the night of the 28th—29th August he gave orders for the advanced position to be occupied. On the 29th Oku and Nodzu were in touch with him. There followed desperate encounters on the Russian right and centre, in which Oku and Nodzu lost heavily and made little progress. On the early morning of the 1st September however Kuropatkin retired from his advanced position, leaving the Japanese to carry empty trenches. The Russians occupied their second line. Oku and Nodzu rested a day in front of it, and we will leave them there while we examine more fully the adventures of Kuroki on the Japanese right.

Returning to the 29th August we find Marshal Oyama issuing his orders for the general attack. In these he gave directions for the advance of the 2nd and 4th Armies which have been referred to above, but was strangely silent as to the 1st Army, except that the Guard Division was ordered to co-operate with the 4th Army in an attack on the hills by Meng Chia Fang. We know, however, that on the 29th, Kuroki was expecting to cross the Tai Tse Ho and was making preparations to do so. The morning of the 30th found his forces as follows:—the Guards in front of Meng Chia Fang, the 2nd Division facing almost west between Ta Shi Men Ling and Shih Chu Tsu, and the 12th Division concentrated at Hei Yu. Opposing the 2nd and 12th Divisions north of the Tai Tse Ho was Bilderling's XVII. Army Corps on the hills between Hsi Kwan Tun and San Wa Tsu. Space is hardly available to describe the attack of the Guard Division on the 30th, and it will be enough therefore to say that although carried out with the greatest vigour, it failed, and by nightfall the Guards were back in the trenches they had left at dawn, having lost heavily, particularly from the Russian artillery fire. More interesting are the movements of the 2nd and 12th Divisions. At midday Kuroki received reports which inclined him to think that the Russians were evacuating Liao-Yang; at 1 p.m. therefore he gave the order to cross the Tai Tse Ho. The 12th Division and the 15th Brigade, 2nd Division, were to ford the river at Lien Tou Wan, while the bridging trains with an escort of infantry were to move on Chiang Kwan Tun and make a bridge for the field artillery and train. These movements were carried out; the 23rd Brigade, leading, reached Lien Tou Wan at 11.30 p.m., and all the infantry of the 12th Division were across by 6 a.m. After them, the 15th Brigade, 2nd Division, crossed. No opposition of any kind was met and the troops marched to the positions indicated to them by Kuroki's order, being all in position by 4 p.m. on the 31st, on the ridge facing due west between Kwan Tun and Shang Fen Kow. The bridge at Chiang Kwan Tun was built by the sappers between 3 and 8 p.m., and consisted of

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34 pontoons and some trestles, about 180 yards long, the superstructure being covered with millet straw. "Chasseur's" comment on the whole action is as follows:—"We can only say that, as a strategical move, this decision (to cross) on the part of the Japanese staff was on a par with the incompetence of General Orlov, who allowed this solitary, unsupported, and detached division to make the passage of the Tai Tse unopposed, when he was in a position not only to have prevented the crossing, but to have overwhelmed the division while in the act of crossing." Orlov commanded a Russian flank detachment, near the Yentai coal mines, and while we may agree with this criticism of the Japanese grand tactics, it seems hardly fair to put the blame on Orlov: surely the officer at fault was Bilderling, who was charged with the duty of watching the Tai Tse Ho, and whose cavalry it was that first observed the Japanese crossing. Kuroki moved his headquarters from Anping to Hei Yu on this day.

Although the Japanese crossing had been seen at 6 a.m., the Russian cavalry commander who saw it did little to pass on the information, and nothing to stop the crossing. Bilderling did not act on his own initiative, but referred to Kuropatkin. A telephone breakdown delayed the message and Kuropatkin only got it at 11 a.m. He then put into operation the "Disposition No. 3," which he had prepared during the previous night; by this Bilderling was ordered to defend the Hsi Kwan Tun position, while part of the army in front of the 2nd and 4th Japanese Armies was to retire on the second line of defence. Of the rest the 1st and 3rd Siberian Army Corps and the Xth Army Corps were to cross the Tai Tse Ho near Liao-Yang and move east. Kuropatkin had thus committed himself to a slow and ponderous offensive against the three Japanese brigades north of the river, intending to overwhelm them while holding the 2nd and 4th Armies on his southern front. Comment is needless, rapid action on the 31st by Bilderling in co-operation with the flanking detachments of Orlov, Orbeliani and Samsonov (the two latter being cavalry) must have swept Kuroki back into the river, while there seems no good reason for abandoning the advanced position south of Liao-Yang, which had not been forced at any material point by Oku or Nodzu.

Kuroki, receiving reports as to the position of his brigades, and as to the enemy in front of them, issued his orders during the night 31st—1st September. The 15th Brigade was to capture Manju Yama, and the 12th Division prolonging the line to the north was ultimately to intercept the Russian line of retreat on Mukden. It is clear that he still thought that the Russians were evacuating Liao-Yang, and that he was only opposed north of the river by a strong rear-guard.

By the early morning of the 1st September, Bilderling's corps,

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following out the Disposition No. 3, was in position as follows:—on the left, 2 battalions held the small hill called by the Japanese "Manju Yama," or "rice-cake hill"; near Hsi Kwan Tun 2 battalions with a few companies pushed forward beyond the village, and on the Hill 920, a regiment, 4 batteries in the fields between Sha Ho Tun and Hsi Kwan Tun; this composed the left section. The right section (3rd Division) on the Hill 1057 does not concern us, the general reserve, at Sha Ho Tun, consisted of a little over 2 battalions, 5½ squadrons and 8 batteries. The following additional Russian forces were on the same flank:—Orlov, with 3 regiments and 8 guns, and Samsonov, with 4 cavalry regiments and a battery, near the Yentai coal mines; Mischtchenko, with 4 cavalry regiments and 2 batteries, near Sai Chia Tun; Orbeliani, with 3 cavalry regiments, near Ta Yao Pu; and on the far eastern flank, Liubavin's detachment, of 2 cavalry regiments and 4 guns. The latter was opposed to the Japanese Guard Kobi Brigade, under Umezawa, which had crossed the Tai Tse Ho further east and was acting as an outer flank guard to Kuroki's army.

Against these forces Kuroki launched his three brigades. Crossing the river himself at Chiang Kwan Tun, he viewed the battlefield from a small hill. Manju Yama to the west, and the hill of Wu Ting Shan, 5 miles to the north-west, stood out from the millet which covered the low country and even reached near to the top of Manju Yama. Reports reached him that the Guards and 4th Army were in possession of the Ya Yu Chi position, and he resolved to advance boldly, still thinking the Russians in retreat. A message from Oyama directing him to act with caution he disregarded, thinking no doubt that his superior knowledge of the situation justified his doing so. Only luck, bad Russian leading, and his own splendid infantry, saved him from disaster.

At 7 a.m. the Japanese advanced, the 12th Brigade on the right occupied Wu Ting Shan, and the 23rd turned a weak Russian force out of Kung Ku Feng, but the 15th Brigade (its commander realizing that Manju Yama was strongly held) waited for the guns to prepare its attack. The artillery of the 2nd Division had crossed the river by this time, and at 8.30 the guns of both divisions, distributed along the ridge south of Wu Ting Shan, opened on Hsi Kwan Tun. They were replied to by Russian guns behind Hsi Kwan Tun. It will be noticed that Kuroki kept no general reserve—another indication that he expected little resistance—but he had sent for part of the 3rd Brigade, which had previously been with the Guard Division. These troops arrived in driblets during the day, and were posted behind the 15th Brigade.

The 15th Brigade advanced at 11.30 a.m.; at 1 p.m. Inouye, commanding the 12th Division, receiving reports of strong hostile forces on his right, sent word that he could no longer advance nor

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help the 15th Brigade. These forces must have been Orbeliani's or Samsonov's cavalry, possibly both. Okasaki, the commander of the 15th Brigade, decided, however, to go on; he asked that all guns might be concentrated on Manju Yama, and this being done, succeeded in getting in daylight within a thousand yards of Manju Yama, in spite of the fact that the Russian guns, reinforced from the corps reserve, almost silenced those of the Japanese. Nearer however he could not get, the infantry garrison of Manju Yama having been reinforced by another regiment.

The turn events were taking was very disquieting to Kuroki. Instead of a mere rear guard, he had found a strongly entrenched force blocking his way to the west, while a force of unknown strength was reported advancing against his right flank. However, he was too far committed to retire, and he acted boldly and wisely in going on with his attack, merely sending for the rest of the 3rd Brigade and the 29th Kobi Regiment, and informing Umezawa of the unknown force on the right.

Okasaki was still burning to advance, and in the evening received permission to do so and carry Manju Yama by night attack. At 7.20, guns opened fire, and soon after the infantry advanced. The right section moved more quickly than the left, having easier ground; the Russian regiment on the north of the hill fell into temporary panic, but was rallied. However, the Japanese succeeded in establishing themselves on the north of the hill, while a fierce fight still went on further south. The extreme left section of the Japanese turned a large Russian force out of Hsi Kwan Tun with unexpected ease, and turned north, taking the hill in flank. At this moment—11 p.m.—a counter-attack with bayonet and hand grenade was made by three Russian companies, but unsuccessfully. Hand-to-hand fighting in the dark went on for some time, and a second counter-attack was launched, but the Japanese always had the upper hand, and soon after midnight were in possession of the hill.

During this day Orlov arrived near the coal mines, where he joined Samsonov about 2 p.m. He saw the fighting on Manju Yama, but made no attempt to interfere, simply entrenching a position between the coal mines and Fang Shen. Samsonov seems to have done nothing during the day. He and Orbeliani managed to check the Japanese advance beyond Wu Ting Shan, but only by presenting the appearance of a large force. This was probably the worst thing they could have done. They might either have moved round the Japanese flank and taken Inouye in rear, so inflicting much damage on him; or by remaining out of sight have drawn the Japanese on still further till Orlov and they could have effected a surprise and possibly cut off the 12th Brigade. Liubavin on the extreme east continued to retire before Umezawa.

Kuroki had every reason to be pleased with the situation on the

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morning of the 2nd September, and the more so when the news arrived that Oku and Nodzu expected to be in Liao-Yang during the day. As a fact, they had advanced on the day before towards the Russian second position and anticipated little trouble there, but as it turned out they met with a stubborn resistance which delayed them for two days more. However, Kuroki read this message to mean that the Russians were in retreat on the east, and so for the second time he was deluded into a too optimistic view of the situation. He issued his orders on that assumption ; the 12th Division to pursue the enemy towards Lan Ni Pu, the 2nd to capture Hill 920 and pursue to Lo Ta Tai. Umezawa was to move on the Yentai coal mines.

To turn now to Kuropatkin. During the night 1st—2nd September, he prepared his orders for the great counter-stroke which was to overwhelm Kuroki's little force. This was before he heard of the loss of Manju Yama during the night, and he clearly intended to use this point as a pivot of manœuvre. His orders—the "Disposition No. 4"—were as follows:—The XVII. Corps was to hold the Hsi Kwan Tun position (which in reality it had lost), the 3rd Siberian Army Corps to move to Chan Hsi Tun and act as reserve, the 1st Siberian Army Corps (Stakelberg) in two columns, to Yang Chia Pu Tse and Liu Lin Kou, the X. Corps (Slutschevski) to march on Fan Chia Tun, and Orlov to advance southwards towards the Japanese right and rear, getting touch with Stakelberg before moving off. These movements all began and were carried out in substance, with the exception of Orlov's. That officer's troubles and defeat must now be dealt with.

On the night of the 1st—2nd Orlov received two messages from Bilderling, requesting him to co-operate with him in attacking the Japanese at dawn on the 2nd. He prepared to move at 4.30 a.m., but meanwhile received another order directing him to act "in the manner which has been indicated to you." This referred to the Disposition No. 4, which he had not yet received, and much perplexed he sent to ask Bilderling what it all meant. He had not heard the result of the fighting on Manju Yama. He could get no answer out of Bilderling, but soon after dawn he heard from Dobrshinski (commanding 35th Division) that there had been fighting on Manju Yama during the night, the result of which was not known. The Russian communications must have been in a bad state on this day, and dearly Kuropatkin paid for this. Orlov, rightly thinking that anything was better than inaction, prepared to advance against the Japanese position on Wu Ting Shan. His guns opened at 6 a.m. ; there was little reply, and at 8.30, leaving 2 battalions near the mines, he advanced with 5½ battalions in the front line and 4 in reserve. Near Ta Yao Pu he came suddenly into collision with Japanese infantry, and the head of his column was thrown into disorder. His troops, it should be noted, were mainly reservists and the latest arrivals from

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Russia. The force he had met was, of course, the Japanese 12th Division, advancing towards Lan Ni Pu in accordance with Kuroki's orders. The battle which followed in the dense millet was short and sharp, infantry only being engaged. Orlov brought up his reserves, but a Japanese battalion got round his left flank, and his men were no match for the Japanese in this variety of fighting. He now heard of the loss of Manju Yama, and he reported that he was unable to effect a junction with the 1st Siberian or XVII. Corps and that he was retiring on Yentai station. This retirement rapidly became a rout, but near Hsiao Ta Lin Kou his troops ran into the head of the left column of Stakelberg's 1st Siberian Army Corps. Stakelberg managed to rally one battalion, which Orlov personally led in counter-attack against the Japanese near Fang Shen, a regiment of the 1st Siberian Corps assisting him. Orlov was wounded and his battalion fled again, the bulk of his command eventually arriving at Yentai station in utter rout. Stakelberg however continued his counter-attack on Fang Shen; two regiments of his command and one of Orlov's (rallied) were in the front line, and two more in reserve; but they could do no more than check the advance of the Japanese, even when, about 4.30 p.m., the right column of Stakelberg's command came up. This column had been delayed by cavalry blocking the roads—seemingly a strange method of employing the mounted arm.

Vague rumours of Japanese forces on the extreme east now began to be heard. These were of course Umezawa's detachment, which in reality was far from the scene of action. However, the rumours were sufficient to cause Samsonov, who with his cavalry was still near the mines, to withdraw to the north-west. This circumstance, and the fact that a Japanese battalion soon after occupied the mines, decided Stakelberg to retire, and at 6.30 he withdrew to Hsiao Ta Lien Kou, and during the night reached Liu Lin Kou, whence he had started in the morning.

To return now to the Manju Yama side. Kuropatkin, arriving at Fan Chia Tun at 10.30 a.m. on the 2nd, had three successive reports from Bilderling. The first told of the repulse of a Japanese attack on Manju Yama, the second told of its capture by the Japanese, and the third of Bilderling's intention to recapture it at once. These were confusing, and the situation was the more obscure owing to the fact that no Japanese could be seen on Manju Yama—they were on the reverse slope and therefore concealed. Kuropatkin issued no definite attack orders, merely directing his corps to get into touch with each other. At 8 a.m. Dobrshinski, acting under Bilderling's orders, commenced his counter-attack. He was reinforced by a brigade of the 5th Corps, under Ekk. A few companies of a Japanese battalion had been pushed forward to the spur south-west of Hsi Kwan Tun. When the Russians advanced these troops were ordered by Okasaki to retire. Their commander, however, begged to be allowed to

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hang on, and these companies put up a game resistance, but were eventually withdrawn. The remainder of Dobrshinki's force, after an artillery preparation, advanced against the hill soon after 8 a.m., but they were met by a hot fire at close range, and were brought to a standstill about 1 p.m. It was now decided to wait for darkness to recapture the position. Kuropatkin heard about 3.30 p.m. of Orlov's disaster, and warned Stakelberg not to press on until he could be supported, though this officer had never shown any intention of doing anything so rash.

The preparations for the great attempt to recapture Manju Yama now began. At 2.30 guns opened, and by 5 p.m. 152 Russian guns were bombarding the hill. The Japanese did nothing, except for reinforcing Okasaki with some troops of the 3rd Brigade. Twenty-six Russian battalions were ranged in the front line for the assault, and strange as it may seem the chief command was given to Slutschevski, who commanded the X. Corps (the reserve behind Hill 920). This officer was new to the country and junior to Bilderling. He consequently placed himself under Bilderling's orders, and, as before, Dobrshinski was given the actual task of carrying out the attack. This began at 6 p.m., but no headway was made till dark. Between 7 and 9 p.m. repeated attacks and hand-to-hand fighting took place, hand grenades being used on both sides, and balls of magnesium wire being lit by the Russians and flung in front of the Japanese trenches to light them up. At 9 p.m. Okasaki suddenly ordered the "Cease fire," in an instant it was obeyed—a tribute to the perfect fire discipline of his troops—and he was able to estimate the strength of the Russian attackers. He received reinforcements, and the struggle became hotter than ever, and at 2 a.m. a final attack by 7 battalions was made. The Japanese 30th Regiment, however, this time did not wait to be attacked, but moved out and fell on the left of the Russian line, which was completely surprised and retired on Sha Ho Tun. The Japanese had thus been completely successful in retaining possession of the hill, but were far too exhausted to pursue.

At midnight Bilderling had reported that Manju Yama was retaken. Whether he was misled by some small local success, or whether the wish was father to the thought, is not known, but it is almost certain that the report was not at any instant true, and in any case it was a very premature moment for the commander to report a definite success.

Kuropatkin, receiving this report, had every reason to be satisfied with the trend of events. He could still make his great attack on the morrow, using the (supposed recaptured) Manju Yama as his pivot of manœuvre. But at 3 a.m. the situation changed. Zarubaiev, in command at the bridgehead at Liao-Yang, reported that his reserves were all in action and asked for reinforcements; Stakelberg,

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announcing his retirement on Liu Lin Kou, stated that his corps was too exhausted to fight—it should be noted that this corps had suffered greatly during the 29th and 30th August south of Liao-Yang—and Bilderling, correcting his previous report, acknowledged the failure of his counter-attack and reported that his corps had fallen back on Erh Tao Kou and Hill 920. Perhaps these cumulative set-backs were too much for Kuropatkin, he still had overwhelming forces on the north of the Tai Tse Ho (much of the 3rd Division and X. Corps and all the 3rd Siberian Corps being untouched) but his heart failed him, and he ordered a general retreat on Mukden. This was at 6 a.m. The Japanese 15th Brigade had turned the scale, while Orlov's disaster had been the first nail in the coffin of the Russian hopes for that day.

On the morning of the 3rd, Kuroki, realizing that the Russian retirement which he had so often expected was really beginning, sent an order to the Guard Division to cross the river and help in the pursuit. On the previous day he had requested Hasegawa to attempt to cross and capture Hill 1057 from the Russian 3rd Division, but the Guards had not responded to his call. They were perhaps the least satisfactory of the Japanese infantry, being mostly men from the larger towns. Hasegawa again refused to attempt to cross, but finally towards evening was prevailed upon to send a brigade across by Chiang Kwan Tun. These troops had a long and difficult march and did not reach the bridge till the next morning; they were followed by the remainder of the Guard Division, and all eventually got across, too late to be of any use. Had they forced the passage near San Wa Tsu—which they should have been able to do—they would have been able to pursue the retreating Russians, which the remainder of Kuroki's troops were far too exhausted to do. During the day the 3rd Brigade replaced the gallant 15th on Manju Yama, but no forward movement was possible to the rest of the First Army.

We need not go into the details of the Russian retirement on Yentai station. Kuropatkin threw out a screen to cover his withdrawal, and a thick mist helped him also. Kuroki issued orders for a general pursuit at 2.30 p.m. Umezawa's detachment came into action on this day at Tu Men Tsu, where a much superior force of Russian cavalry were held in check, the action being indecisive.

During the night the Japanese were able to pursue to some extent. Between 2 and 3 a.m. the 12th Brigade ran into Stakelberg's rear guard near Post No. 8, and a desperate encounter took place. The Russians lost heavily, and at dawn continued their retirement, having successfully checked the pursuit. Kuropatkin had issued detailed orders for the retirement, and it went on all day, the block on the roads and in the villages being in places appalling. Had the Japanese not been too exhausted to pursue the retreat must speedily have become a rout. As it was, Yentai station was evacuated by 2 p.m.,

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Japanese guns having just begun to shell it from Lan Ni Pu, but at this time it became apparent to Oyama that further pursuit with his weary troops was out of the question, and he decided to give them the word to halt and take a much-needed rest.

The losses on both sides were large. The First Army lost 1,200 killed and 5,000 wounded, while the total Japanese loss was 5,500 killed and 18,000 wounded. The Russians lost 2,600 killed, 15,000 wounded, and 1,000 missing, so that it is clear that the Japanese had to pay dearly for their strategical victory. By it however they convinced all critics of their ability to win battles against superior forces, and more than this can scarcely be expected of any army.

In the above necessarily short account little criticism has been possible. One of the most important lessons of the battle seems to be that in modern war a change of plans on a large scale is frequently fatal. There are two instances bearing this out in opposite ways. Take Kuropatkin's case first. He had massed his reserves behind his right flank and obviously meant to make his great counter-stroke there. He heard of Kuroki's movement, straightway changed his plans, and marched all his reserves over to the left. This took three days, during which his front line had such a bad time that they could not hold on till the counter-attack could be delivered, and he had to retire his whole force. Suppose instead he had adhered to his original plan, told Bilderling and Orlov that they *must* hold Kuroki for a day or two—and this they should have been able to do—and moved out his reserves on the 31st against Oku's left flank, they would have had a good chance of cutting up Oku's tired troops, who could not easily have been reinforced, and Kuroki would possibly have been ordered to retire back over the river and reinforce the left. The fact is there is no time in war to march the general reserve from end to end of a line 30 miles long, and it is often better to make the counter-attack in the wrong place at the right time, rather than in the right place at the wrong time.

In the second example, Kuroki crossed the river thinking that his task with Bilderling's rear guard was an easy one. He found he was utterly wrong. If any one of the Russian commanders (except perhaps the unfortunate Orlov) had been in command of his force, he would have changed his plans and gone back, and probably got badly cut up in re-crossing the river. Kuroki did not; he went on, and luck stood by him; and he scored a success after perhaps one of the most hazardous operations of war on a large scale that has ever proved successful in history.

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SIEGE ARTILLERY—METHODS AND REQUIREMENTS FROM R.E.

A Lecture delivered at the School of Military Engineering by MAJOR R. O. MARTON, D.S.O., R.G.A.

I FEEL that we should commence this subject with a review of the Organization of our Siege Artillery. Unlike perhaps any other branch of artillery, where it may be said that there is a comparative certainty that it will be used in, and is necessary to all operations in war, siege artillery proper is generally designed to meet only a certain set of circumstances, namely the attack of more or less permanently fortified places. Furthermore, it is possible that the necessity of engaging in such operations may only appear after the war has been in progress some time, or at any rate probable that the campaign will have had to have been conducted to some successful point before such operations can commence. (Examples, Adrianople and Port Arthur). Time is not such an important factor therefore, and, in a sense, the readiness and organization of a siege train is not so essential as in any other branch of artillery. There will be time enough, so to speak, to get our siege train together when we know what we are likely to have to attack, and we may feel fairly confident on having a certain amount of time in which to collect it, organize it, and polish up its training. What we shall probably not have time to do, however, is to make our guns and ammunition—they must exist. We may perhaps be able to buy them. We especially, from our geographical position, do not consider it necessary to keep any considerable establishment of regular siege artillery even on a peace footing. We have a very small and highly trained nucleus and do our best to prepare for a possible expansion on mobilization. It must be noted, however, that this nucleus has to be trained, not only to play its part in regular siege operations, but also to be ready to join in with the movements and fortunes of the field armies. It has really only just commenced its practical training for the latter function, and I think it may fairly be said that up to the present its employment in this respect is expected to be limited to the preliminary operations of a siege, in driving the defenders back into their main lines of defence (such as from the Battle of Nanshan to the final investment of Port Arthur). Dealing first with the *personnel*, our nucleus consists of three companies of garrison artillery, each of which is capable of, and

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is specially organized for expansion into two batteries on mobilization. The organization in half companies and sections facilitates this expansion, and a double number of the many so-called specialists, which the exact and highly technical methods of siege artillery render necessary, are trained so as to be ready for this expansion. For any further expansion it is expected that the coast artillery will furnish the necessary *personnel*. For local defence many companies of coast artillery are trained in the use of movable armament, consisting of both guns and howitzers, light and medium, and obtain thereby some experience in firing over land ranges, which is so very different from firing over sea ranges. To form a basis of some knowledge in siege artillery methods, apart from the ordinary interchange of officers between Siege and Coast Artillery, courses in siege artillery instruction are held at Lydd, which are attended by Coast Artillery Instructors in Gunnery and about 20 officers and 100 N.C.O.'s from Coast Defence Companies annually. The companies themselves in their stations also go through a short siege course under the eye of the instructors before mentioned. It is not expected naturally that such limited training will produce any very high degree of efficiency, but it will certainly form a basis for the further instruction to be given after mobilization and the necessity for the formation of a siege train has appeared, and we have seen that in all probability some time will be available for this to be given.

As regards armament, two or three companies are armed with the 6-in. B.L. howitzer, called a medium howitzer, and the other with the 9·45-in. howitzer, or heavy howitzer.

The four batteries of 6-in. B.L. howitzers manned by the first two expanded companies will be formed into one medium brigade, and will be horsed and provided with two ammunition columns, one to each two batteries. This is the only brigade that will be a mobile unit, even if other 6-in. howitzer batteries are formed. The two batteries of the other expanded company will be formed into a heavy brigade with no ammunition column.

Other heavy guns in our possession in limited numbers are 6-in. B.L. guns. Also a certain number of 9-in. H.A.F. guns which were eliminated from our coast defence. The guns of the movable armament consist of field guns, 5-in. howitzers, 4·7-in. Q.F. guns and 6-in. B.L. howitzers.

Reviewing all these weapons, the newly designed howitzer will be the siege howitzer in chief, and judging from the results of Port Arthur the 6-in. howitzer (apart from its short range) cannot be expected to obtain any great effect against modern permanent fortifications.

Now, the capture of a fortified place, however important it may be, does not in itself mean that a war is going to be brought to a successful conclusion. The destruction of the enemy's field armies is the knock-

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out blow and the one from which there is no recovery. The object of the defence therefore is not only to attempt to retain possession of its fortress from its own intrinsic value, but to detain as large an attacking army for as long as possible in front of its walls, and so prevent it from participating in the field operations which are going to decide the ultimate fate of the war. Similarly the object of the attack is not only the capture of the fortress for the reasons which made it necessary to attack it, but also to do it in the shortest possible time so as to free the besieging forces to take part in the really decisive operations. I do not think that, with modern appliances, any fortress, however impregnable its position, and however well supplied, could hope to hold out for an indefinite time, even if we consider only the actual operations of war and leave out such incidentals as the gradual failure of the resources of the defence. Time is therefore the great factor, and to gain this the defence must husband its resources by providing cover for its troops (which it does by means of its fortifications) and protecting its artillery, which it can best effect by concealment. "The attack perhaps can afford to be more lavish of its troops," but is compelled in a similar manner to conceal its artillery as far as possible. At Port Arthur the Russians apparently sacrificed a great deal of concealment in order to gain command, and they admit that a great portion of their exposed artillery was put out of action or seriously damaged in the bombardments at the commencement of the siege. In fact, it can only be a question of time, and not a very long time either, for guns in visible exposed positions to be knocked out by an efficient and well-served artillery in concealed positions. The accuracy of modern observation of fire makes it impossible for them to maintain themselves. On the other hand, certain Russian guns, which were well concealed and were never accurately located by the Japanese batteries, came unscathed through the whole siege. Concealment, so as to preclude accurate observation, is therefore the essence of artillery protection, and the problem is how best to attain it without preventing the guns from efficiently performing their duties. Concealment from terrestrial observers is a fairly easy task, especially as the vast majority of siege artillery weapons will consist of howitzers employing curved fire. The advent of aerial observers, however, has most enormously increased the difficulties of concealment and, incidentally, many other of the important details of siege warfare. I am going to leave out of consideration any questions regarding actual attack from the air and only discuss the effects of observation from the air. Further we will not dwell on the effects of observation from captive balloons, whose radius of action are somewhat limited, and whose comparative fixity of position does render them fairly vulnerable to artillery attack. I do not mean that such balloons could not often obtain most valuable

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information, and be of the greatest assistance in observation of artillery fire, but it would probably be infinitely easier to conceal things from their eyes than from an observer in a free moving and dirigible flying machine. It does appear that it will be impossible to conceal anything from the eyes of a trained aerial scout, and if both sides possess an efficient service of this form, it is difficult not to come to the conclusion that they will both have excellent information of each other's dispositions.

It has not yet been proved with what degree of impunity a flying machine can scout over an enemy's position. If only we could say that an aeroplane must keep above a certain height to enjoy a certain immunity, we might be able to gauge the amount that he could spy out the details of our dispositions. How is such an enemy to be destroyed ? Can the usual destroyer of things at long distances, namely artillery, do the trick, or must we rely on aircraft to destroy aircraft ? We know that most countries have produced, or are producing, artillery to deal with such targets, and are thinking out all sorts of scientific methods of dealing with them, but their success is purely theoretical. Certainly an argument against considering them as artillery targets is that no practice at them under anything like service conditions is imaginable, and it is dangerous to leave things to be decided in actual war. Unless we can get some sportsman, with a supreme belief in himself and a magnificent contempt of all artillery fire, it seems that we shall have to fall back on the hopeful business of " it will be all right on the night." Perhaps we shall have to rely on their destruction by their own kind, which should prove an operation containing sufficient excitement to satisfy the most ardent spirit. It is possible that we may develop some of the wild animal's instincts for concealment, and we certainly ought to gain information from our flying corps as to the best means of making observations difficult. One cannot help feeling that accurate observation will be vastly more difficult than it sounds, even when no attempt is made to interfere with it. We all saw the headlines in the newspapers after this year's army manœuvres, " War Made Easy," etc., etc., but yet a whole division of the defending force was never located at all up to the evening before actual contact. One could understand the troops hiding under hedges, etc., but how about guns, vehicles, transport and horses. Some of the former, one heard, were hidden under hay, but the animals cannot have been concealed under one of their staple forms of diet ! I have never heard it satisfactorily explained. The next consideration is, whether the locating of batteries in positions only visible from the air by such scouts is going to involve their destruction. It seems doubtful whether the mere general locating will be very dangerous unless it is supported by some system of observation of fire. We know that under favourable conditions and with observers who had not had any very great

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amount of experience in observing under such conditions, good results have been obtained by artillery fire directed by observations from captive balloons. It was possible to maintain communication between battery and observer. It remains to be seen whether an aeroplane can similarly act as an observer for artillery. The intercommunication will be difficult. I believe the French are trying a system of signalling from an aeroplane, by blowing off the exhaust of the engine through a box full of soot and making thereby a sort of dots and dashes business. It is a proud thought, the use of soot in the country's service, and should raise the social status of the sweep. We may find out something on this subject in the near future, as detachments of the flying corps are going to visit artillery practice camps this season, with this object in view. Assuming that the aerial observer cannot approach very closely, it has been found that the best form of battery emplacements to favour difficulty of detection, consists of perfectly plain pits, without any parapets or hard form lines; the howitzers to be sunk in these pits with their muzzles flush with the ground when elevated for firing, all the excavated soil entirely removed, and surface of any disturbed ground made to agree with its surroundings. If it was necessary to guard against detection by aerial observers, it would be necessary to construct the pits by night, and this, combined with having to assimilate them with their surroundings before daylight and the removal of excavated soil, is going to make it all a slower process. The R.A. are trained to construct their own batteries, but of course the necessary tools and materials for construction of splinter proofs and battery expense ammunition stores do not form part of the equipment they carry. In *Military Engineering*, Part II., a normal type of sunken siege battery is given, showing the general nature of its requirements, and the rough construction of such batteries is practised in our practice camps. It is probable that they would have to be rather more elaborate in actual war, if for no other reason than that they are going to be occupied, lived in, and fired from for some considerable period of time. The drainage and sanitary arrangements would have to be carefully attended to and, under certain circumstances, field casemates provided in addition to splinter proofs. In the same book it is stated that siege batteries should be protected by wire entanglements against capture by surprise. No doubt they would have to be if their position was such as to render a surprise attack possible, but in view of the distance that they will always be behind the advanced lines, it is difficult to imagine how such a necessity can arise, and the existence of such obstacles might well give away an otherwise concealed battery. The R.A. are not trained in the erection of such obstacles.

We have seen that we shall generally have to take on concealed targets, which we can claim to do with a fair amount of

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success if they can be located and our fire at them even temporarily observed. If we can be told that any round has fallen close to any target, we can direct our observation of fire instruments upon that point and then maintain an accurate fire upon it. I am afraid that if the target is in such a very concealed position that the smoke of our bursting shell cannot be seen or accurately observed, we should then have to rely on further aerial observation or on the expenditure of a large amount of ammunition to complete our task.

Now the supply of ammunition is a very large question, and one that the R.E. are directly concerned with as far as providing the means of carrying out this supply is concerned.

I should like to preface this question with a few remarks on the "front of attack." A French writer, "Rouquerol," has argued that the "front of attack" or "the part of the defensive lines against which the attack is going to concentrate its efforts," will have to be chosen during peace time, as so many arrangements will have to be made in good time to prepare for the handling and movement of the immense weight of stores necessary for the carrying on of the siege of a first-class fortress. He says it will be too late or cause too much delay to postpone this decision until after the investment has taken place. Of course there are such considerations as "suitable artillery positions," "success to give decisive results," "ground in the zone of attack to be favourable to sapping" which help to govern the choice of the front of attack, but the general topography of the fortress should be known beforehand. The chief practical problem will be the organization of the means of bringing up the immense weight of stores and ammunition to the front of attack, and Rouquerol estimates this is in the case of a siege of a place like Metz or Verdun to be something like 200,000 tons or more. This necessarily involves the use of a line of railway and such huge depôts as the advanced supply and ordnance depôts must be on a railway. It also follows that besides being suitably placed to feed the front of attack they must be absolutely out of all possible artillery range, or from 10 to 15 miles at least away. Our present arrangement is to keep one day's supply of ammunition at the battery, another day's supply at an intermediate depôt called the Brigade Ammunition Depôt, inasmuch as one of these is formed for each brigade, and to keep replenishing the supplies from the advanced ordnance depôt. The principles which should guide us in the selection of the positions for these intermediate Brigade Ammunition Depôts have often appeared rather obscure. Certain conditions, such as concealment and security from artillery fire and facility of access, are laid down for them in our training manuals, and naturally there is in practice a tendency to try and get them as far forward as possible to lessen the work and time involved in supplying the batteries from them. In a sense, security from fire can only be secured by getting out of range, which nowadays means a consider-

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able distance. Concealment may give security, but with aerial observation will concealment be possible? Such a depôt may not be a very visible object, but if it is depending on concealment for its security from fire, it is possible that no work or movement can take place there in the hours of daylight. Besides which, if we are going to use any form of light railway to supply these depôts and also the batteries, these lines will afford an excellent guide to show the aerial observer where to look for depôts and batteries. The argument therefore is that we must not expect to get very much security from concealment, and that our depôts and batteries must be dug in and protected by artificial means. Now if we protect our ammunition in this way, we must just examine what work we expect to perform at such depôts and whether it is practicable. Of course this is assuming all the time that they are within range of the hostile artillery. I may mention here that there may well be positions within range, such as quarries or behind very steep slopes, where security from fire may be obtained entirely from the nature of the ground, and it would not matter a scrap whether depôts were located in such positions or not. No artillery fire could hurt them or the workers at them, and naturally full advantage would be taken of such places and the nearer they were to the batteries the better. Now the advanced ordnance depôt will be served by, and be situated on a broad gauge railway, whereas the batteries will have to be served by a narrow gauge line. We certainly cannot consider it practicable to supply them with the heavy weights of ammunition they will require by any other means than some form of light railway. Therefore somewhere between the A.O. Depôt and the batteries there must be a break of gauge, and the problem is where it should be. Wherever it takes place there will have to be a handling, unloading and loading, of these heavy weights of ammunition. The Brigade Ammunition Depôt is certainly the most forward position that we can consider such a change being made at, and will it be possible to carry out such work and display such movement at a place we are either trying to conceal or know has been located? Probably not. It would also seem an unnecessary thing to break the gauge at any point between the Brigade Ammunition Depôt and the A.O. Depôt. Again when we consider the gradients that may have to exist on the narrow gauge lines and the weights that have to be pulled up them, we are forced to realize that the tractive power must consist of some form of light engine. Besides it would be extremely uneconomic and a great waste of labour to use any other form of power. From a summary of all these arguments, it seems that there is scope for a considerable alteration in the system of our ammunition supply which at the best is only rather roughly outlined in our training manuals. The difficulties always become apparent at our staff rides, and aerial observation has increased them. We have

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started always with the basis that Brigade Ammunition Depôts must exist, since it is laid down that they should.

The suggestion that I now venture to make is that they should not exist and that the batteries should be supplied direct from the A.O. Depôt over narrow gauge lines the whole way, the break of gauge occurring at the latter place where it would be very convenient. To this I would add that a larger supply of ammunition should be maintained at the batteries than one day's consumption. Both Russians and Japanese kept more in their batteries than we do, and a Russian authority has suggested that it ought to be still further increased, as communications are so liable to interruption. At Port Arthur the Japanese had several of the Russian communications to the city under observation, and the appearance of a single horse and cart was sufficient to draw an accurate fire upon it; this was carried on to such an extent that the Russians had to give up these communications in daylight and had to construct roads over much more devious routes.

At present 200 rounds a piece for medium howitzers is kept at the battery and is reckoned as a day's supply. For heavy howitzers half that amount is allowed, though if the new howitzer is going to be the siege howitzer proper, it is not easy to see why 200 rounds per heavy howitzer should not be considered a day's supply for them. It does not mean of course that 200 rounds a piece will be fired every day, but that it is an amount that may well be fired on important occasions and which we must be ready to replenish.

Computing only for medium howitzers, a day's supply works out at about 160 tons for a brigade of four batteries, or 40 tons a battery. Now I may as well go straight to the point and say that we want a great deal of information about the means with which this duty is going to be performed. Very little is mentioned about it in any official textbook. We do not know how much, or where, or in what form much of the necessary material exists, such as rails, trucks or engines. The form of engine is certainly important if it is going to work right up to the batteries either by day or night. What weights will it pull and up what gradients, and what weight will each truck carry, and also what may be taken as an average speed of a train under normal circumstances. Naturally the position of ammunition depôts and in fact the whole system of ammunition supply as exemplified by the suggestions I made about it, is bound up in the answer to some of these questions. It seems doubtful whether the time which we referred to before, as being likely to be given us to complete our preparations after the commencement of war, will be sufficient, unless these details have been considered beforehand.

As siege artillery only exists in very small quantities in peace time, our practical training only deals with small quantities. Consequently there is always a danger of our methods becoming more suitable for these small numbers than for the large body of artillery that would be

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necessary for first-class siege operations. Owing to the reasons of our fire always being indirect, our ammunition heavy, and therefore not lightly to be thrown away, our rôle of attacking material demanding very exact fire, our methods have become very technical and requiring a high degree of training. It has also complicated our communications and these we are only partly responsible for. In *Military Engineering*, Part II., is given a diagram showing the whole of the telephone communications that are considered to be necessary to have the show running properly. It is a formidable lot when applied to a large force, and I think that another argument is added in favour of my suggestion of cutting the brigade ammunition depôt out of our system of ammunition supply. The artillery only carry, lay and maintain the lines in the artillery system below the station of the artillery brigade commander, which are necessary for the fighting of and control of the batteries. In the remaining lines of the artillery system there appears to be some reduplication. For instance the Brigade Ammunition Depôt is in communication with the battery commander, the brigade commander and also the advanced ordnance depôt. The channel for all reports on expenditure or wants of ammunition is through the officer commanding siege artillery, who issues the necessary orders to the advanced ordnance depôt for ammunition to be sent to the brigade depôts. However nice and convenient it may be therefore for everybody to be in telephonic communication with everybody else, there seems to be rather a waste of effort or rather an extra addition to an already rather complicated system.

Judging by Port Arthur, both artillery and command lines, in any places where they are liable to damage from hostile fire, should be laid underground. The Russians I believe used overhead lines almost exclusively and as a consequence their communications were always failing them at the most critical moments.

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TRANSCRIPT.

ABOR EXPEDITIONARY FORCE.

REPORT ON ENGINEERING OPERATIONS.

By MAJOR E. C. TYLDEN-PATTENSON, R.E., *Assistant Director of Works, Abor Expeditionary Force.*

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1. *Kobo.*—No. 1 Company, 1st King George's Own Sappers and Miners, and 32nd Sikh Pioneers arrived at Kobo on 28th September. The following works were carried out at Kobo :—

(i.). Enlarging and clearing site of Base camp.

(ii.). Water supply from Abyssinian pumps. These pumps were of the greatest value.

(iii.). A road was cut for 3 miles towards Pobamukh, which became the steamer terminus when the Dihang fell too low to allow steamers to reach Kobo.

(iv.). A landing stage was erected for steamers. This was made of crib-work, the logs being 18 ft. long by 4 ft. girth, and the piles were driven 6 ft. into the river bed. This was totally washed away on 12th October when the Dihang rose 17 ft. Such a flood at this season had been unknown, the river reaching summer flood level.

(v.). Salvage of the river steamer *Scinde*, which ran on to the fluke of an anchor and settled down on to the river bed. Sappers and Pioneers, working continuously in relief for 60 hours at 13 pumps, got the water out and the Sappers caulked the holes temporarily. But for the work of these troops, the *Scinde* would probably have become a complete wreck during the flood of 12th October.

(vi.). On 10th October ½ company, Sappers, with a detachment Pioneers marched to Kemi River on Oniyuk road and built a light trestle bridge for foot traffic. This was carried away by a 9-ft. flood on 14th October. On October 16th, the half company of Sappers commenced a "Jhula" or country bridge which was completed on the 17th. This bridge was made of bamboos interlaced between six 1-in. steel wire cables; the span being 140 ft. On October 17th a trestle bridge was commenced and finished on the 18th when the Sappers returned to Kobo.

(vii.). Various works in camp, roads, drains, incinerators, etc.

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2. *Kobo to Pasighat.*—On 22nd and 23rd October the force advanced from Kobo in two columns, and reached Pasighat in four marches. As far as Pilung, the road had already been improved by the Public Works Department. Between Pilung and Lokpur the path was bad, being blocked by many falling trees, so that progress was slow. Sappers and Pioneers removed trees as far as possible or made hasty ramps over the large ones. Between Lokpur and Pasighat the path was better, the jungle consisting of smaller trees and less undergrowth.

3. During the halt at Pasighat, from 26th to 28th October, a defensible post was made for the advanced Base, the road between Lokpur and Pilung was improved, and the Sappers and Pioneers also worked on the road forward, reaching the top of Red Cliff, $4\frac{1}{2}$ miles from camp, on 28th. At Red Cliff the path entered the hills, the ground hitherto having been flat.

4. *Janakmukh.*—On 29th October the force advanced to Janakmukh. During the march, Sappers and Pioneers worked on a new alignment of zigzags leading down from Red Cliff to Janakmukh Camp on the bank of the Dihang.

5. From 30th October to 1st November, during the halt at Janakmukh, the Sappers and three companies of Pioneers completed the road from Pasighat, made a post at Janakmukh, and carried the road forward $1\frac{3}{4}$ miles to the Sijon stream, where the road leaves the Dihang.

6. *Rammi Dumbang.*—On 2nd November, the force advanced to Rammi Dumbang. The Abor path rose at an easy gradient from the Sijon stream to camp, which was in a large clearing made for cultivation. The road was completed into camp.

7. From 3rd to 5th November, the Force halted at Rammi Dumbang. The Sappers and one company of Pioneers made the road forward to Sirpo Camp. Throughout this stage, a new line was taken to Coolie Col and down to the Sirpo valley. The latter part was a steep descent which had to be negotiated in the short time available by continuous zigzagging.

8. *Sirpo.*—As far as Sirpo Camp the gradient had been made at or under 1 in 7 and the path was passable by mules, but required widening before being fit for daily convoys; it was considered that the Pioneer companies on the line of communications could complete this widening gradually.

9. Beyond the Sirpo River was a very sharp rise of about 1,000 ft., the Abor track going straight up to a slope which in places was as steep as 1 in 2. To save time, it was decided to make a coolie track at 1 in 5. This was finished on 8th November. The road was also continued from camp down to the Sirpo River along a steep cliff down which the Abor track was carried by means of a ladder. A 25-ft. bridge was built over the Sirpo.

10. *Renging.*—On 9th November the force advanced to Renging, and the road was carried on from the Sirpo Col to a point above Renging Camp.

11. Between Renging and Rotung the road works round high hills on the left.

These are offshoots from Bapu Mountain, and form steep spurs and deep valleys radiating out to the Dihang, which lies hidden in a deep gorge on the right.

The Abor track crossed four nullahs taking a more or less straight line

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regardless of the descent or ascent involved. The names of these nullahs and intervening spurs or cols are:—

	Approximate Heights.	
	Abor Track.	New Road.
Renging Col	2200	2200
Marshing Nullah	1500	2300
Jhum Spur	2500	2500
Yernu Nullah	1900	2750
Yernu Col	3000	3000
Lalek Nullah	1600	1700
Razor Edge	2150	2150
Igar Bivouac	1600	2000
Rotung Col	2350	2350
Rotung...	1100	1100

This necessitated the finding of an entirely new alignment. From each Col, the next Col was visible, but the intervening valley was mostly out of view and its sides covered with dense jungle, precluded any accurate estimate of the nature of the hillside. It therefore only remained to determine the approximate gradient which would hit the next Col and to cut a line forward on it, trusting to chance not to run into a cliff which would involve a retreat and a fresh trial line above or below the cliff. On the steep hillside the jungle generally limited the view to 20 or 30 yards. The actual roadmaking was not difficult, the soil being soft and rock disintegrated; the chief delay being the cutting and removing of the larger trees.

12. During the halt at Renging the weather was very bad, the troops, with a bare 10-lb. kit, being wet all day with little chance of getting dry on return to camp. On arrival at Rotung the Sapper Company had 20 per cent. sick.

13. The troops available for roadmaking were the Sappers and one company each of the Pioneers and 1-8th Gurkhas. These latter were invaluable in cutting the jungle with their kukries. The remaining seven companies of Pioneers were required for garrison and escort duty on the line of communications, and were able to do but little work improving the road until relieved by the 1-2nd Gurkhas about the middle of December. Work was further delayed by the precautions which had to be taken, the steep hills and dense jungle affording the Abors ideal opportunities for stone shoots and ambuscades.

14. On November 18th the road was open into the Lalek Valley, and on the 19th the Force advancing to the Igar stream, captured the Igar stockade. On the 20th Rotung was reached. The road from Razor Edge to Rotung Col had to be made at once, as the Abor track was impossible even for Nagar carriers.

15. *Igar Valley.*—The Igar Valley proved to be the most difficult section between Kobo and Kebang, the ground being very steep and often rotten and treacherous: the alignment took three days and the making of the road another five. Time after time the trial trace ran into impossible ground and a fresh line had to be cut.

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16. *Rotung Ferry.*—On 30th November, the first attempt was made to cross the Dihang at Rotung. For tactical reasons the crossing was to be made at night. The narrowest site available for the crossing was in a stretch of the river just below a rapid and about half a mile above the next rapid. The width in the narrowest part was 180 yards and the current variable up to 6 miles an hour. On the far side was a cliff of rock rising some 30 ft. above water level and on the near side the bank was covered with immense rocks rising up at a steep slope.

17. The materials available for the crossing were *Wheatley bags*, line, wire, and steel wire cables $\frac{5}{8}$, 1, and $1\frac{1}{2}$ in. in circumference. The Wheatley bags were filled beforehand; to save weight, a small gabion, 2 ft. high and 1 ft. diameter made of split bamboo, was wrapped round with rope of rice straw, and placed in each bag. It was found that this method reduced the dead weight of a bag to 63 lbs. as against 80 lbs. when stuffed with straw only; moreover there is not so much straw to become waterlogged.

18. A raft of 10 bags was made up with bamboo framework, and Lieut. Cave-Browne, R.E., and five Sappers tried to row across with a line at 5.20 p.m. The current and drag of the line proved too strong and the line had to be cut to enable the raft to reach the far bank above the rapid. An attempt was at once made to run out an "otter," 5 ft. by $2\frac{1}{2}$ ft., which had been previously prepared, but the otter would not go further than half-way. Work was now being carried out by moonlight. After several attempts and various readjustments the otter dived and became fast in the river bed, so at midnight further attempts had to be abandoned.

19. At dawn on December 1st Lieut. Cave-Browne, R.E., recrossed with the raft. The failure of the otter appeared to be due to the whirlpools in the river which overturned the otter. During the day, therefore, two larger otters were prepared and an attempt was made to run one across at 5.20 p.m. Again this method failed. The otter 6 ft. by 3 ft. dived and broke away, and another 8 ft. by 4 ft. kept rising and falling over. At 1 a.m. work was stopped and the party bivouacked on the bank.

20. Next morning Lieut. Cave-Browne, R.E., crossed with a raft at dawn and seven successive attempts to run the otter failed. Various alterations were tried in the lengths of the bridles, etc., and finally, bamboos were lashed along the water line of the otter to increase its buoyancy and the weight of the keel was increased to give more stability.

The raft was attached to the far bank by a 1-in. steel cable and swung out about one-third across the river and at the eighth run of the otter, Lieut. Cave-Browne succeeded in catching its tail. The position now was that the raft and the otter were in midstream 200 yards from the near bank and 150 yards from the far bank. The joining of the two cables was a difficult and hazardous operation in the heavy water, and was successfully carried out by Lieut. Cave-Browne, who then cut the otter adrift. It was now 5 p.m. and there were only five men on the raft who were very much fatigued, so the raft was recalled. As it was, the crew could only just succeed in making the near bank.

21. As more men would be required on the far bank next morning, a rectangular raft of 16 more Wheatley bags, arranged in fours, had been

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prepared, ready to lengthen the small raft. Work at dawn on December 3rd was again checked by the 350 yards of 1-in. cable having fouled a rock in the river and it had to be cleared by sending the raft out from the near bank along the cable. The large raft of 26 bags was then rowed over with Lieut. Cave-Browne and 12 Sappers. They at once pulled over a 1½-in. cable attached to the 1-in., and the cable was tightened up clear of the water. At 5.15 p.m. the large raft was pulled back to the near side by a ⅝-in. cable attached to a traveller running on the 1½-in. cable. At 5.30 p.m. the first party of 20 Gurkha scouts was ferried over, the crossing being completed in 19 trips at 10.35 p.m. when the Maxim gun detachment of the Assam Valley Light Horse, 2 companies, 1-8th Gurkhas, 1 company, 1-2nd Gurkhas with Maxim, ambulance and reserve ammunition carriers had crossed.

24. *Rotung to Yambung.*—On 4th December the Force advanced and captured the Kekar Monnying Stockade and camped at Sidé. The Sappers and 1 company, 1-8 Gurkhas, demolished the stockade, cut down 40 stone shoots and repaired the track through Kekar Monnying.

25. On 5th December, the Sappers improved the path back towards the Sireng River.

26. On 6th December, the Force advanced to Puak and Sappers worked on 6th, 7th and 8th on Coolie track from Sidé to Puak and 1½ miles on towards Kebang.

27. On 9th December, the Force destroyed Kebang. The Sappers and 1 company, 1-8th Gurkhas, worked on Coolie track towards Yambung, which was finished on 11th.

28. From 12th to 15th December the Sappers and Gurkhas cleared the site of the new Yambung camp. One company Pioneers at Puak improved the Coolie track near that post.

29. *Yambung Ferry.*—On 29th December, the Sappers established a ferry across the Dihang at Yambung. The first line was taken across by a Berthon boat, which had now been received from the Base. No difficulty was experienced, a good site being available for the crossing, where the river was very deep and current about 3 miles an hour. The crossing of the boat was covered by two Maxim guns, and two rounds were fired from the wooden mortars which threw shells containing 3½ lbs. dynamite well into the jungle on the far bank: the explosion of these shells was sufficient to frighten any Abors who might have been concealed in the jungle. As soon as it was seen that the line had been successfully taken over, a raft of 32 Wheatley bags, carrying 16 Sappers, was rowed across by five pairs of oars. With the help of the first line, cables of ⅝ and 1½-in. steel wire were pulled across in succession. As at Rotung, the raft was attached to a traveller, running on the 1½-in. cable and the traveller was pulled across by ⅝-in. cable from each bank. A capstan was built for winding in the cable. (Subsequently on 12th January a raft of Polianski bags were tried in place of the Wheatley bags and proved satisfactory).

30. On 22nd December, a section of Sappers under Lieut. Cave-Browne, R.E., re-established the Rotung Ferry which had been dismantled on 5th December on the return of the right flank attack after

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the capture of Kekar Monnying stockade. A strand of telegraph wire had been left up over the river on 5th December so there was no delay in getting the steel wire cable over the river.

31. *Permanent Mule Road.*—On 20th December, the Sapper Company commenced an 8-ft. mule road back towards the Base from Yambung. About 15th December a portion of the 32nd Pioneers had been released from escort duties, and three companies under Lieut. Burn-Murdoch had begun work on the permanent mule road from Razor Edge to Rotung. Lieut. Burn-Murdoch had obtained a good alignment from the Col, involving a 30-ft. cutting, which eliminated the zigzags made during the first advance.

32. On 28th December, the Sappers moved back to Puak where 1 company Pioneers was already working on the mule road. From Yambung to Rotung an excellent alignment was obtained between 80 and 200 ft. above the Dihang, as far as the Sireng, whence the road rises steadily into Rotung, the maximum gradient being 1 in 10. Sappers built bridges over the Puak and Sembong streams of 25 and 20-ft. spans.

33. On 13th January, the Sappers and one company Pioneers moved to Sidé and were joined by another company of Pioneers. The Sappers built a cantilever bridge of 45 ft. over the Sidé, and cut the road through Kekar Monnying in solid rock, some 100 yards.

34. *Sireng Bridge.*—On 30th January, a half-company of Sappers moved to the Sireng stream and commenced work on a suspension bridge 84-ft. span, dip 1-12. All woodwork was sawn out of logs. The timber available was all heavy, being as much as 72 lbs. per cubic foot. The roadway was 4 ft. wide between ribands and 6 ft. between handrails, to take laden mules and infantry in single file. Braces to the handrails and inverted cables gave great stiffness to the bridge. The left frame was on top of a rock cliff and the right frame on a cribwork pier built on solid rock foundations. Eight 1½-in. steel cables were used on account of the great weight of the roadway due to the high specific gravity of the timber. The completion of the bridge was delayed by the cables not arriving from Calcutta until 23rd February; it was finished on the 27th when the section remaining at Sireng marched to Rotung.

35. *Rotung Post.*—On 30th January, a half-company of Sappers and two companies of Pioneers marched to Rotung, whence they finished the road down to the Sireng Bridge and commenced building a Post at Rotung for the Military Police, to accommodate 200 men. The Post was enclosed in a stockade of bullies, 6 to 8 in. diameter, 8 ft. high, with barbed wire fence, ditch, and "panjies" outside. The stockade was rectangular, 73 yards by 63 yards, with two bastions at opposite corners.

36. The general type of building was 48 ft. long by 25 ft. wide (15-ft. room with two verandahs each 5 ft. wide). One barrack of this size was allowed for each section of 25 men. All buildings were raised 2½ ft. off the ground on logs resting on dry stone walls. Floors and walls were made of split bamboo. Roofs were designed for corrugated iron sheets, but pending sanction for necessary expenditure, roofs were temporarily covered with split bamboo and 18 ft. by 12 ft. tarpaulins

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supplied by the Supply and Transport Corps. Officers' bungalows and mess were floored with sawn planks. The Post was well drained being sited on ground with a slope of 1 in 10 to the west. The collection of materials, stone, logs, bullies and bamboos entailed a considerable amount of labour, and great assistance was received from working parties of 1-2nd Gurkhas and Carrier Corps.

37. On January 30th, the remainder of the Pioneers were now road-making, five companies being at Upper Rotung working on the road to Razor Edge, and one company at Renging. About the 10th February, the Pioneers completed the road from Rotung to Lalek stream, and moving to Renging, finished the road from Renging to the Lalek by the end of February, a new alignment giving a practically level road round the Marshing Nullah from Renging Col to Jhum Spur.

38. Between 1st and 5th March three sections of Sappers and five companies of Pioneers moved to Sirpo Camp. The Sappers built a suspension bridge across the Sirpo and made the approaches on both banks, whilst the Pioneers carried on the road by a new alignment, $2\frac{1}{4}$ miles total length, rejoining the old road just above the new Abor village at Roi. The gradient was 1—10 and the new line reduced the ascent from Sirpo Stream to Coolie Ridge by 300 ft., besides cutting out the old 1-7 zigzags, without lengthening the road.

39. *Sirpo Bridge.*—The Sirpo Bridge was 100 ft. span, 60 ft. above water level, with roadway of the same type as at Sireng Bridge. There were 12 cables $1\frac{1}{2}$-in. steel wire, arranged in half parabola, dip 1-10th. On both banks the cables were carried straight to the anchorages without any frames. On the right bank the cables ran straight up from the longest sling into the cliff, to a shore transom resting on solid rock, behind which a platform was blasted out 12 ft. wide. On this platform an anchorage was made with boring bars. Each set of six cables was fastened to a hard wood anchor, 4 ft. 8 in. by 6 in. by 6 in. with a $1\frac{1}{2}$-in. boring bar forming its core. This anchor was fastened behind a row of four jumpers set in holes 3 ft. deep. The heads of these jumpers were tied back to two more jumpers, whose heads again were tied back to one jumper, like a 3, 2, 1, picket holdfast. The whole anchorage was covered with dry stone walling to a height of 4 ft. With braced hand-rails and inverted parabolic wind-ties a good stiff roadway was obtained. The method for adjusting the main cables is worthy of mention. Each $1\frac{1}{2}$-in. cable was fastened permanently to one anchorage, and after a turn had been taken round the other anchorage, was stretched as tightly as possible by block and tackle and temporarily fastened with clips. After all 12 cables had been stretched once, they were again stretched, as the first cables had sagged owing to the anchorages taking up their permanent bearing under the accumulated strain. This left the cables on a catenary with $1\frac{1}{4}$ ft. deep. The length of the cable in this catenary and in its final position on bridge, viz., that of a parabola with a straight back guy, having been calculated, it became necessary to pay out the difference, which in this case was $14\frac{1}{2}$ ins. Four inches were allowed for stretching under full load, and $10\frac{1}{2}$ ins. were paid out which length was carefully marked on each cable.

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The result was most satisfactory, each set of six cables lying perfectly even at the required dip of 1-10th thus ensuring an equal distribution of the total load and it was unnecessary to readjust a single sling, which fully justified the time taken in stretching the cables. The slings were attached to flat iron plates bolted above and below the six cables.

40. Meanwhile one company of Pioneers working from Renging metalled the zigzags down to the new Sirpo diversion, where the road passed through soft wet ground which had become impassable for mules in the recent rain.

41. *Balek Post.*—On 25th March, the Sappers marched from Sirpo to Balek to build a Post for the Military Police. Lieut. F. S. Collin, R.E., and two companies Pioneers had already built the stockade and were collecting bullies and bamboos for the huts. Another company of Pioneers also arrived later. The Post was built for 100 men, the huts being of the same type as at Rotung, but were raised off the ground on piles instead of on stone walls.

42. On 27th March, the remainder of the Pioneers left Sirpo and moved down to Pasighat and Kobo, but two companies halted a week at Janakmukh to improve the road in that neighbourhood and also to make a new mule road from Janakmukh to Balek.

43. *Work above Yambung.*—Whilst at Balek, two detachments of Sappers rejoined the company. On 9th February, Lieut. Chater, R.E, and two Sappers had left Sireng for Geku, and had been followed on 21st February by 20 more Sappers. This party established a ferry over the Dihang below Geku, using a raft of Polianski bags. Between 28th February and 2nd March, the Tibet exploration and survey party crossed by the ferry to the right bank, and the ferry was dismantled. The Sappers proceeded to Riga and Arte Hill where they cleared the trees on the hilltop for survey work. Leaving Arte on 24th March the party reached Balek on 2nd April.

44. The other party, consisting of one squad of Sappers under Jemadar Sultan, left Rotung on 26th February and improved the path up the right bank of the Dihang above Yambung, made eleven footbridges and one ferry over various streams and assisted survey work by improving tracks and clearing jungle for observation stations. This party rejoined at Balek on 28th March.

45. *Pasighat Post.*—On 8th April, the Post at Balek was sufficiently advanced for the Military Police to complete. The framework of all buildings had been finished and it only remained to fix split bamboo for floors and walls. Sappers and Pioneers therefore moved to Pasighat to build that Post. The Pioneers left Pasighat for India on 10th April, and the Sappers were assisted in clearing site, digging the ditch, collecting materials, etc., by two companies 1-8th Gurkhas, detachment Military Police and 300 Gurkhali Carriers. The Post was built for 100 men, rectangular in plan, 50 by 66 yards, with a double-storey blockhouse at two opposite corners. A stockade was not considered necessary, but could be added. A breastwork was made inside the ditch from the trunks of trees felled in clearing the site. As no sanction had yet been received to the proposal submitted in January, to provide corrugated

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iron roofs, the roofs were built at a steeper slope to carry thatch. In seven days the clearing of the site was completed, including the removal of some immense trees; the framework and split bamboo flooring of all buildings was finished, one hut was thatched, and planks were sawn for flooring the officers' quarters.

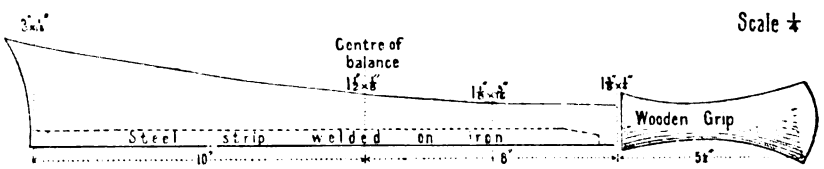
46. The Post being so far advanced that it could be finished by the Infantry and Carriers, the Sappers left Pasighat by half-companies on the 16th and 17th April and embarked on the *Kabul* at Pobamukh on 18th April.

APPENDIX I.

NOTES ON ENGINEER EQUIPMENT.

1. *Delisle Clinometers.*—At present only two Delisle Clinometers are authorized in the equipment of a field company of Sappers and Miners. I consider that this should be increased to four. The weight is very small and the addition could be made without reducing any other articles. These clinometers are essential for laying out hill roads and there should be at least one per British officer in the company, not to mention the Indian officers. These instruments are as essential on the North-West as on the North-East Frontier.

2. *Dahs.*—For the Abor Expedition a kukri or dah was issued to each Sapper. A kukri is perfectly useless in the hands of anyone but a Gurkha, who has been trained to its use from youth, moreover the kukries issued by the Ordnance Department were of inferior metal. The dahs also were of a bad pattern and material. Whilst awaiting the advance from the base at Kobo, I saw some Kampte dahs belonging to an officer of the Lakhimpur Military Police and bought some for the Sapper Officers, and carried one myself in place of a sword throughout the expedition. This dah was invaluable for cutting jungle in aligning the road and with it I could compete on equal terms with the Gurkha and his kukri. The dah is shaped thus—



The weight is 1 lb. 6 ozs. The grip was rather too small for an Englishman. The blade is made of soft iron with a thin strip of steel on one side only: the other side is sharpened on a stone as required, the steel side remaining flat. The balance is excellent and the blade cut through young saplings with ease. This weapon should be issued to everyone except Gurkhas on another expedition on the North-East Frontier.

3. *Axes.*—I agree with Capt. Le Breton's remarks about felling axes used on the Mishmi Mission, that the slot in the head to receive the helve is too small: this necessitates a very thin helve which constantly broke just below the head especially when axes had to be lent to Infantry who were unskilled in their use. It must be remembered that on service it is not always possible to get spare English helves and the best local wood has to be used.

4. *Explosives.*—The explosives supplied from the Arsenal were very satisfactory and I had no trouble with guncotton, dynamite, fuze or detonators. In a damp climate like Assam one should always use a fresh tin of primers or else use dynamite as a primer to fire guncotton slabs.

5. *Crossing Rivers.*—The whole difficulty is to get the first line across. In the case of a big river like the Dihang, when boats are not available or the current is too heavy to let a boat take a line over, an "otter" appears to be the best method, but an otter will not work satisfactorily unless there is a fairly *even* current. At Rotung, the Dihang kept boiling up in eddies which upset the otter. On the other hand I got an otter at the first attempt successfully across the Cabul River in the Mohmand Expedition, 1908, width 200 yards. Maximum current 6 miles an hour, but there were no eddies. I think experiments should be made to devise a rocket to carry a ⅜-in. line 250 yards. I understand that marine lite-

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saving rockets carry a much heavier rope about 150 yards, so that there should be no great difficulty in obtaining our requirements. I believe that a marine rocket apparatus is very heavy: a light equipment is required that at all events can be got on two mules. These rockets could be kept in an Arsenal, a few being issued yearly to Sapper and Miner Corps for practice. When an expedition goes into a country where large rivers will be met, these rockets would be specially issued. The saving of one day in crossing a river might mean the saving of one day in the duration of the expedition, the financial gain of which would well repay the cost of the proposed equipment.

6. *Wheatley and Polianski Bags.*—Separate reports have already been submitted on these bags and I strongly recommend that some of each pattern be kept in reserve. Polianski bags should be stored in a hill station where extreme dry heat would not injure the rubber bags.

7. *Venesta Equipment Boxes.*—Twelve experimental boxes were made up in the 1st King George's Own Sappers and Miners workshops, smaller than the ordinary mule equipment box, to carry tools, etc., in 60-lb. loads suitable for coolies. For over five months the Sapper Company was entirely dependent on coolie transport, and these boxes were of the greatest value and stood the test well. A small reserve of these boxes might be maintained for similar expeditions.

The old boxes have been given into the 1st King George's Own Sapper and Miner workshops as patterns.

APPENDIX II.

List of Stores Expended from Engineer Field Park.

Axes, helves, 34½"	No.	84	Wire nails, 2½"	lbs.	40
Axes, helves, 16"	,,	30	Wire nails, 3"...	,,	188
Mauls, helves, 34½"	,,	200	Wire nails, 4"...	,,	388
Sandbags	,,	231	Wire nails, 5"...	,,	230
Mamooties, helves	,,	36	Wire nails, 6"...	,,	244
Shovels, helves	,,	55	Spikes, 5"	,,	84
Bars jumping, 1½" ...	(in anchorages)	15	Spikes, 7"	,,	700
Galvanized iron wire No. 14	cwt.	25	Spikes, 9"	,,	734
Barbed wire	,,	3-2-16	Screws, 1½"	gross	1
Dogs, 15"		19	Screws, 2½"	,,	1
Dogs, 12"		44	Screws, 3½"	,,	1
Pencils, carpenters		24	Screws, 5"	,,	1
Saws, handles		8	Composition, waterproof ...	lbs.	2
Cordage, Manilla, 3"... ...	fathoms	150	Oil, Rangoon	gallons	5
Cordage, Manilla, 2"... ...	,,	62	Oil, mustard	,,	1
Cordage, Manilla, 1½" ...	,,	150	Turpentine	pints	2
Canvas, sail	yards	25	Dynamite	lbs.	800
Canvas, Willesden	,,	41	Guncotton, primers	,,	50
Lines, Hambro'	skeins	10	Guncotton, slabs	,,	510
Twine, country	lbs.	20	Gunpowder	,,	150
Log line, 1½"	skeins	20	Cordite	,,	50
Log line, white, 4 lbs. ...	,,	10	Detonators, octuple	No.	800
Spun yarn	lbs.	20	Detonators, sextuple... ...	,,	700
Solder	lb.	1	Fuze, safety	fathoms	500
Copper sheet	lbs.	4	Matches, Vesuvian	boxes	36
Tin sheet, 20" × 14'	sheets	6	Leather, buffalo, light ...	lbs.	30
Steel, round, ½"	lbs.	32	Ropes, steel wire, ⅜"... ...	fathoms	2,400
Steel, round, ⅜"	,,	12	Ropes, steel wire, 1"... ...	,,	700
Steel, round, ¼"	,,	10	Ropes, steel wire, 1½" ...	,,	1,100
Steel, round, ¾"	,,	40	Clips for wire cable, ¼" ...	No.	4
Steel, flat, 2" × ⅜"	,,	31	Clips for wire cable, ½" ..	,,	11
Steel, flat, 1½" × ¼"	,,	29	Clips for wire cable, ⅜" ...	,,	10
Steel, flat, 1½ × ½"	,,	18	Wheatley bags	,,	60
Steel, flat, 2½ × ½"	,,	2	Polianski bags	,,	125
Bolts, ⅜" × 9"	No.	2	Pitch	lbs.	40
Bolts, ⅜" × 6"	,,	2	Sal ammoniac	,,	10

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REVIEWS.

A SHORT ACCOUNT OF RAILWAYS FOR THE USE OF OFFICERS AND N.C.O.'S EMPLOYED IN GUARDING LINES OF COMMUNICATION (NOTIONS SOMMAIRES SUR LES CHEMINS DE FER À L'USAGE DES OFFICIERS ET SOUS-OFFICIERS DU SERVICE DE GARDE DES VOIES DE COMMUNICATION).

By A. LAPLAICE.—(85 pp. and 50 figures in the text. Paris, 1913. Berger-Levrault. 2 francs).

THIS is a very valuable little work. It gives a very clear idea of the French railway lines, rolling stock, signals, etc., and should be studied by all R.E. officers likely to be employed on railway work in Europe. The French methods of working are somewhat different from our own, in which for instance violet and yellow lights are unknown as are also the round disc signal and its attendant "protection post," the square signal to stop, the direction indicator, the chequered warning signal and the bifurcation signal. One has often wondered what three red lozenges on the side of a truck meant; it is an exclusion mark, indicating that the rolling stock in question is unfit for the transport of soldiers, horses and war material.

Apart from the subject matter of the work, it furnishes useful explanations of the meanings of French technical railway terms, which it might puzzle even an "interpreter" to translate, *e.g. en palier*, *accotement*, *tendeur* (this is not a "tender" but a "coupling"), *tirefonde*, *coussinet*, *pattes de lièvre*, though *boggie* (*sic*), *ballast* and *tender* present no difficulties.

"E."

APPRENTICESHIP TO WAR (L'APPRENTISSAGE DE LA GUERRE).

By COLONEL GORY.—(8vo. 135 pp. Paris, 1912. Chapelot).

THIS is a very thoughtful volume. The title is derived from the author's theory that as few of the soldiers of the French Army have seen war, they are mere apprentices, learning as best they can to play a military *rôle*. Whilst in all the other professions the members are trained by incessant practice of their art, officers may complete their service without ever having done anything else but simulate the practice of war. Army manœuvres are excellent to teach the preparation for, and preliminaries of a battle, but prove nothing regarding the actual fighting, and as all danger is absent a mere useless simulacrum is produced.

Colonel Gory next discusses the various means by which officers can

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be trained :—study of history, study of the theory of war, conferences, examinations, essay writing, tactical problems on the map, staff tours, manœuvres. He insists that the second part of the Franco-German War proves decisively that it is indispensable that officers should receive a good theoretical training :—"to organize corps, whose leaders have no military instruction and know no more than the rank and file, should be considered a criminal absurdity."

He is opposed to examinations as the sole means of testing an officer's fitness ; they are, he says, merely a means of enabling a general who is not sufficiently in personal touch with his officers to form some sort of opinion of them. If a general carefully watches his officers, he will get a better idea of their capacities than by judging as a result which depends more or less on a good memory.

"E."

GERMAN AND ENGLISH TACTICS.

By COLONEL EGGERT VON ESTORFF.

THIS very interesting work is well worthy of careful study. It deals with the S.A. War and is divided as follows :—

A.—Fights before the Investment of Ladysmith ;
B.—Fight at Colenso on the 15th December, 1899 ;
C.—Fights on the Tugela, January—February, 1900 ;
D.—The Defence of Ladysmith ;

with comments in each case.

The Army Review of January, 1913, contains the following summary of the preface :—"Recent events have led people in Germany to pay more attention to the British Army and its tactics than they have done heretofore. Both the German and British Armies have submitted their tactical creeds and regulations to a searching criticism and correction since the Manchurian War."

The history of events under the above heads is an extremely clever condensation of the *English History of the War in South Africa, 1899–1902*, Vols. I. and II., but the comments are entirely the author's own. In these he criticizes or appraises our failures and successes almost entirely by the light of our own regulations. In doing so he shows so intimate a knowledge of them that few English officers can excel, if equal it. In many places he brings together apposite quotations from Field Service Regulations, Cavalry Training, Artillery Training, Infantry Training, Musketry Regulations and the *Field Service Pocket-Book*, so that by a general perusal of the book an almost better knowledge of the interrelation of the regulations can be obtained than by reading the regulations themselves.

A few extracts will more readily serve to show the interest of the book than a further description would do. The following extract from the description of the battles north of Colenso, 20th—25th February, will

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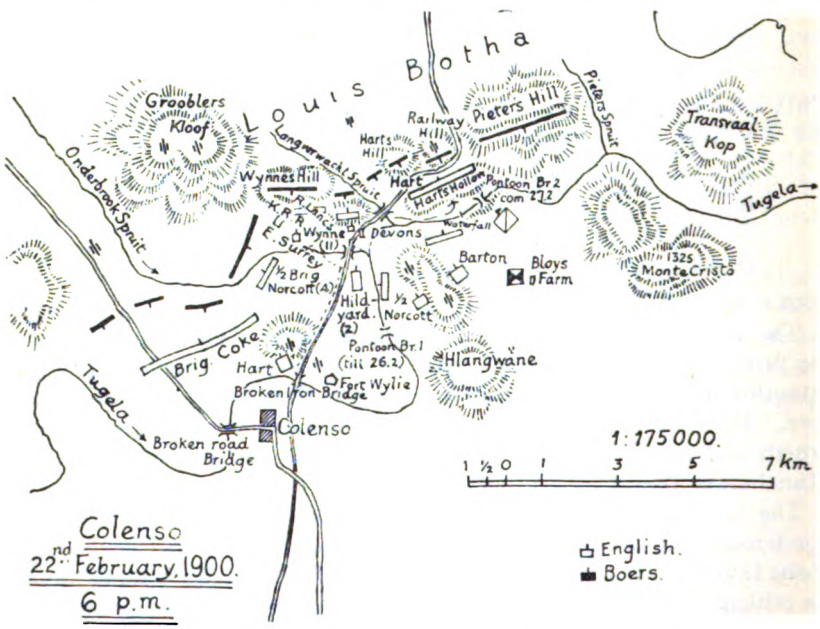
serve another purpose as well, though the analogy hereafter adduced did not occur to the author of *German and English Tactics*:—"Buller spent the 20th February in making a reconnaissance from Monte Cristo, and as the ground eastward of Pieter's Hill seemed to afford no passage for an army across the river, he determined to bridge the river north of Colenso and to drive the Boers back from the river to the west. But in spite of his reconnaissance it was still uncertain where the Boer flanks rested, and this was the cause of the unlucky flank march in the course of the next day between the river and railway which resulted in the brigades attacking one after the other and not simultaneously." This description is somewhat amplified as follows a few pages later on:—"As there was no passage over the Tugela north of pontoon bridge No. 1, the attack could not take place from the front, but Hart's whole brigade had to cross over the iron bridge over the Langverwacht Spruit singly under machine-gun fire; then singly in interminable ranks make a venturesome flank march between the river and its 40—100 ft. high northern bank, in order to make a front and about 5 p.m. take Hart's Hollow with little trouble."



Now to make the parallel, take the following extract from *A Précis of Tactics* by Home, revised by Lieut.-Colonel Sisson Pratt, page 232, on the battle of Kolin in 1757:—"The advanced guard moved as directed, wheeled into line and carried the village of Krzeczor. But while this was being done, the army in its march along the front of the Austrian position was much disquieted by the Austrian light troops, who continually attacked their right flank, a battalion leader being much pressed, ordered his battalion to wheel to its right, as this was the order to form line, it was taken up by the whole army in rear, who wheeled into line also and attacked the Austrians near

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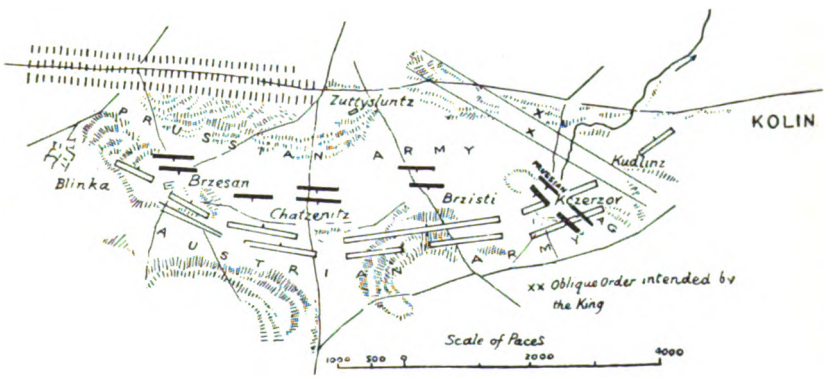
Chotzenitz while the leading portion continued its march, a large gap was thus left in the long columns, and the general commanding the first portion hearing the firing, looked back, saw the remainder of the army in action, and wheeled to his right and thus instead of forming the line XX, the Prussian Army made four disconnected attacks along the front. The Prussians fought well, and renewed the attack five or six times, but were unable to carry any of the Austrian positions, and were compelled to retreat with heavy loss." Napoleon's comment on this was :—"At the Battle of Kolin it is difficult to justify the attempt to turn Daun's right by the flank march made from 600—1,000 yards from the heights occupied by the enemy. The operation was rash and opposed to the principle of war. Never make a flank march before an enemy in position, especially when he occupies the heights at the foot of which you must march." Comment is hardly necessary, the parallel between Sir Redvers Buller's mistake and that of Frederick the Great is almost perfect.



The following extracts will be of more particular interest to R.E. officers. We find under the heading :—"Defence. Field Fortifications," the following :—"The history of the war excuses the bad work on Spion Kop by the fact that there was only 1 ft. of earth over the hard rock, that the stones were too heavy and too deeply bedded to be moved. The Japanese in such circumstances used sandbags, the Boers employed small pieces of stone very cleverly. On the Boer side the Kaffirs had dug narrow deep-cut trenches in the rocky ground and provided head-cover by heaping up big stones. At Colenso they also built false trenches in front of the position which drew the English artillery and infantry fire. The English commission which assembled after the war reported :—The personal skilfulness in the preparation of cover which was so remarkable amongst the Boers, was completely wanting in our regulars, who when entrenching followed orders with difficulty and with no regard to their own cover. At the beginning of the war the troops were neither trained in utilizing cover nor in the application of field defences." Lord Methuen, the commandant at Orange River, adds that :—"The Boers instructed us in the use of small deep trenches whose line was visible with difficulty."

Shortly afterwards, in comments on entrenching in the attack the

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author of *German and English Tactics* quotes General von Bernhardi as follows:—"Positions should be strengthened by the supports against counter-attack, for the reserves often lie idle under cover for a long time, and even on manœuvres might be profitably employed thus during their involuntary leisure." He makes the following remarks on the passage of rivers:—"It so happened that Buller, from December to February, was unable to provide himself with more bridging train, and the preparations for the passage were begun as late as the 20th February, after the Boers had vacated the southern bank. If the reconnaissance and preparation had been taken in hand earlier and with greater care, they would have had at least three places ready on the 20th, the old bridge site and the sites of pontoon bridges Nos. 1 and 2. If the two bridges had been simultaneously in use both at Spion Kop and Vaal Krantz, everything would have been done under more favourable conditions of the river. For if the passage of the army had been accomplished on the night of 20—21st, they would have been able to attack on a broader front at dawn. No decision was come to till the 27th, and the English have only to thank the incredible inactivity of the Boers that they did not sustain more decisive defeats in their earlier fights on the Tugela.

In the English Cavalry Training it is now laid down as a fundamental rule that three bridges must be thrown across a river, one for the infantry, one for the cavalry, and one for the artillery and wagons. According to Section 108 they consider that a well-trained squadron can pass a river about 50 yards broad in about half an hour with the help of two boats.

The great engineer manœuvres at Rastatt in 1909, and Bromberg in 1910, have only confirmed these general principles. You cannot begin by throwing a bridge across a river in security in the face of a worthy foe. Until sufficient forces are on the spot one must content oneself with getting possession of the immediate surroundings of the passage. At Spion Kop, at Vaal Krantz, and at Colenso the English could ignore this rule unhurt; on the other hand how carefully the Japanese made their preparations for the passage of the Yalu. The cavalry reached the upper Tugela on the 10th January and seized the ferry boat at Potgieter's Drift in full view of Spion Kop. Warren's troops commenced the march from Springfield to Trichard's Drift at 5 p.m. on the 16th January, and reached it on the 17th at 2 a.m., his last wagon passed the bridge at 10 p.m. on the 18th. The condition of the river, the strong stream and numerous boulders, rather than the breadth (12 bays for the first bridge 78 metres long), made things especially difficult. The steep banks also hindered the carrying down of the pontoons. The reconnaissance was only made on the arrival of the troops, whose night march was rendered fruitless by the long wait at the bank at Potgieter's Drift. Lyttelton's Brigade were able to cross without loss by the help of a wire cable stretched across the stream, although the current was very rapid and the water came up to the men's shoulders. At Vaal Krantz building the bridge took 1½ hours under heavy fire from a Maxim, a quick-firing gun also had some shots at them so that the English lost eight men. At Colenso the Boers were completely inactive. Almost at the beginning of the campaign in order to meet the most pressing wants the English

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sent out about 100 pontoons to South Africa, they, however, proved useless. There was sufficient material for temporary bridges, but it was not prepared in time."

In his final comments after his account of the Siege of Ladysmith the author says :—"The engineers were present in much too small numbers, this is still the case in both armies. In bridge construction they failed principally for want of effective material and from insufficient reconnaissance. Draught horses are indispensable both for engineers and heavy artillery."

H. E. G. CLAYTON,
Major, R.E.

HOW TO ESTIMATE: BEING THE ANALYSIS OF BUILDERS' PRICES.

By J. T. REA.—(London: B. T. Batsford, 94, High Holborn. 1913. 7s. 6d. net. 4th Edition).

THE R.E. Division Officer needs no introduction to Rea's *How to Estimate*, a fourth edition of which has just been published by B. T. Batsford, of 94, High Holborn. But it is doubtful if anyone is fully acquainted with the whole of the really useful data and memoranda of which the book consists. The new edition contains much more letterpress and many more illustrations than previous ones, including a section on Reinforced Concrete and notes on Modern Road Construction, while the price is still 7s. 6d. net.

It seems a pity that the chapter on the Cost of Buildings could not have been brought more up to date—the date of the latest barrack building of which the cost and cube rate are given is 1905; while it may be doubted if all the illustrations are really necessary, and add to the value of the book. Most people know what a pair of scissors looks like, but a picture of one is given in the chapter on Paperhanger's Work!

Still no doubt every D.O. will wish to possess this new edition, and will find any amount of use for it.

C.R.S.

REMARKS ON THE FACTORS OF PROMOTION (REMARQUES SUR LES FACTEURS DE L'AVANCEMENT).

By CAPT. DE L'HARPE.—(8vo. 23 pp. Paris, 1912. Chapelot).

THE author discusses the unsatisfactory method of promotion, partly by seniority and partly by selection, in vogue in the French Army. He considers that selection, as at present exercised, opens the door to favouritism, and that the opinion of those serving under an officer might be taken into account. As he quotes "A Minister is easier to influence or to deceive than a whole regiment." Failing some improvement in the rules to limit favouritism, he would seem to advocate promotion by lottery, for he sums up by saying "Everyone prefers accident to injustice; and the act of fate to the decision of a secret tribunal."

"E."

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SOME IDEAS ON FORTRESS WARFARE (QUELQUES IDÉES SUR LA GUERRE DE PLACE).

By COLONEL ROUQUEROL of the French Artillery.—(8vo. 36 pp. Paris 1912. Chapelot).

THIS is an interesting essay on the effect on fortress warfare of high explosive shell, aircraft and other modern inventions. Amongst the various conclusions at which the author arrives are:—that nothing but permanent fortification is likely to be of value, the improvised methods that have been effective in the past will no longer serve, except of course in the case of a field army temporarily on the defensive; that sorties in force only play into the hands of the attacker; that assaults are out of the question, and that mining will be the best method of close attack. He considers that the defenders must be in absolutely bomb-proof works which permit of the use of machine guns. The so-called active defence is dead, advanced positions to delay the enemy only mean defeats and loss of *moral*. Small sorties to destroy isolated detachments, to damage new works and material will still be possible, but they must be surprises, carried out by not more than a battalion without artillery. Scouts with local knowledge will be of more service than cavalry or even aircraft in getting information. He ridicules the idea that aircraft can be of any use in observing the effect of and directing fire. He insists that for the maintenance of the health of the garrison every unit should have its own bombproofs, so that disease and contagion are less likely to spread, and its own bombproof kitchen and latrines. As regards the general organization of a fortress he proposes four lines:—line of forts, line of batteries, second line of forts and *enceinte*. The batteries must all be concealed from view, and the forts connected by tunnel with the central supply and ammunition depôts.

"E."

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NOTICES OF MAGAZINES.

Revue Militaire.

March, 1913.

Imperial German Manœuvres, 1912.

An interesting part of the manœuvres was the crossing of the Elbe between Riesa and Meissen by the Red Cavalry Corps. The German cavalry are equipped with steel double pontoons in the proportion of two to each regiment. Each double pontoon takes six men with their saddles and equipment, the horses swimming. In this manner the whole cavalry corps was passed across the river, which is here from 110 to 130 yards wide, during the afternoon of 9th September and the succeeding night. The horse artillery crossed on the divisional bridging equipment. Two days later the III. and XII. Army Corps and the 9th Division crossed on three pontoon bridges in the same locality. The bridges were constructed in three to four hours, and the whole of the troops were across within six hours from the time the bridges were finished. The new pontoons were used for the first time in manœuvres and were thought well of. Three airships and several squadrons of aeroplanes took part in the manœuvres, and two anti-aeroplane guns, a Krupp shielded gun, and an Ehrard, were attached to the troops. All the aeroplanes carried observers, and useful information was obtained on both sides although nothing particularly noteworthy appears to have been done.

America.

The fortifications at Pearl Bay and Honolulu will be almost completed by the end of 1913. The nature of the defences of the Panama Canal has been settled, and work has begun at the two ends and at certain vulnerable points on the canal. The guns of the batteries are to be delivered by June, 1913. Submarine mines will form part of the defences. The harbour of Guantanamo, in Cuba, has been fortified by anti-torpedo boat batteries, and further work is contemplated; it seems destined to become a place of great strategic importance when the canal is opened.

April, 1913.

Austro-Hungarian Manœuvres, 1912.

Use of Aeroplanes.—Fourteen aeroplanes took part, and in spite of constant rain the majority of them carried out daily reconnaissances, which were of great value as the country in which the operations took place was unsuited for cavalry reconnaissance. The commander of the Southern Army was, by means of them, enabled to locate both the opposing forces at an early period of the operations.

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RUSSIA.

The railway lines purchased by Russia in 1912 from the Warsaw-Vienna Railway Company from Warsaw to Alexandrovo on the Berlin-Moscow line, and from Warsaw to Granica on the Vienna line, are to be converted to the Russian gauge 1·52 metres. The conversion will be carried out gradually and will cost £2,800,000.

'E.R.

REVUE MILITAIRE SUISSE.

February, 1913.

SWISS INFANTRY MACHINE GUNS.

The introduction of machine gun companies into her cavalry in 1898, placed Switzerland in the first rank of progress. She was, however, quickly passed by neighbouring Powers, but fighting shy of additions to the cavalry machine guns on account of the difficulty of providing horses, determined to equip the infantry with them.

After numerous trials the Maxim gun was chosen, conveyed somewhat after the manner of the German *Abteilungen* (4-horse wagons, *personnel* on the wagons or on horses). The organization of the companies contemplates their employment as a fire reserve at the disposal of the higher commanders; they can, however, be distributed to the infantry. This equipment and organization is criticized as not being mobile enough to be brought into action sufficiently quickly at the decisive moment by the higher commanders, and too mobile for ordinary use with infantry. Germany appears to be neglecting her *Abteilungen* in favour of companies attached to infantry with two horse carts and *personnel* on foot, still it does not follow that German methods will equally suit Switzerland. Machine guns moving at the pace of infantry must be distributed at least two per battalion, but with greater mobility this proportion can be reduced.

The organization of the companies is then discussed, and the machine gun described, several photographs being given. The gun-carriage and limber is drawn by four horses and carry the *personnel*. The gun is fired from a tripod, and it and the tripod are so loaded in the carriage as to be easily withdrawn and secured to a pack saddle. It is the same with the ammunition. The off-side horses carry the pack saddles, and when wheels can proceed no further, these are unhooked and the loads transferred to the saddles, the rear leader taking the place of the off wheeler. Again when the country is impassable for horses, the loads can be transferred to the backs of the detachment. The wagon is treated in the same way, the off-side horses carrying extra ammunition. The cavalry machine guns cannot be carried by the men.

The gun and equipment is then compared with those of other armies.

Germany has 16 *Abteilungen* of six guns each, and is credited with the intention of giving at least one of these detachments to each *corps d'armée* for independent use. In 1910 one infantry regiment in each

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brigade had a company of six guns carried by two horses each only. This proportion is being increased and it is probable that shortly each regiment will have its six guns. The weapon is an 8-m.m. Maxim firing the infantry cartridge.

France has some Hotchkiss guns, but has now decided to use a gun of the Puteaux model, which is described. It is not water-cooled.

Italy.—All infantry and cavalry regiments have a Maxim section of two guns, carried on pack-saddles.

Austria.—Each regiment of infantry, battalion of chasseurs, and brigade of cavalry has *Abteilungen* of two guns in the infantry and chasseurs, in the cavalry and mountain infantry regiments of four guns. These are on the Schwartzlose system.

England employs her machine guns on different principles to any other nation, *i.e.* singly. As a rule the section of two guns is the unit of fire. She also uses them at long ranges outside the lines of infantry, which explains the great vulnerability of these weapons in spite of their shields. It would seem that these tactics are tainted with the error that brought discredit on these guns in 1870–71 ; the confusion between their action and that of artillery.

Russia has 120 companies, part drawn on wheels, and part carried on pack-saddles. They are distributed in varying numbers to divisions and brigades. They are mostly Maxims, but the mounted units have the automatic rifle of Madsen model (also called Rexer or Rekyl), which is described.

Japan at the beginning of the war had only a few machine guns in certain cavalry regiments, but added to these considerably. At first companies of six guns were organized, now each battalion has a section, or even one gun. They are mostly Hotchkiss, but some are Maxims.

The conclusions drawn are (1) that the Swiss cavalry system has been emulated by other Powers, (2) that the infantry organization meets the advantages of all existing systems especially from the point of view of transport, (3) that the army possesses fewer of these weapons than is generally considered necessary. Their mobility however partly supplies this deficiency.—(*To be continued*).

The Medical Regulations of the Swiss Army.

The criticism of these new regulations is completed. The chapter on the measures to be taken during the combat is generally approved of. These measures differ according as the engagement is one of encounter or attack, in a fortified position, or during a retreat. The company and its duties, and methods for carrying out the latter are described. Chapter III. deals with the medical arrangements on the Line of Communications, which comprises the 3rd line, Chapter IV. with the arrangements in fortresses, Chapter V. with Reports, and Chapter VI. with the Red Cross. There are also several appendices dealing with various matters.

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THE QUESTION OF INFANTRY N.C.O.'S.

An examination into the causes of the difficulty experienced in finding efficient N.C.O.'s, with suggestions for overcoming this difficulty.

March, 1913.

OUR INFANTRY MACHINE GUNS.

Employment of Machine Guns.—Machine guns have been called "condensed infantry," but they are more. The tripod mounting, or the German wagon admit of reinforcing the firing line, but the impossibility of accompanying infantry at the same pace, and the difficulty of the ammunition supply limit their use for this purpose. These guns should form distinct forces at the disposal of regimental, or in certain cases, of battalion commanders.

In the defensive they should occupy the most vulnerable points of the firing line, or be used for flanking fire. For night work, they should be placed in position by day. They can also be used to search defiles, dead angles and obstacles. Their effect is overwhelming at 200 or 300 yards, but is useless at long ranges against thin lines.

In the offensive they should follow the infantry under cover, and fire over their heads. In their final position they should cover the last rushes of the infantry, and concentrate on counter-attacks. When the position is taken they should be rushed up to co-operate in the pursuit and check counter-attacks. In such cases means of rapid transport are necessary.

In attacking a prepared position, it is still open to dispute whether the machine guns should open fire from the beginning or be held in reserve. Cases are quoted from the Russo-Japanese War in which both methods were employed with success, and the moral effect of their rapid fire was very marked.

The Swiss regulations lay down clear and precise principles for their employment. These principles are much discussed, but it seems clear that the groups of two or three companies in reserve at the disposal of divisional commanders are very useful for surprises, and in actions of short duration against important points. The difficulty of ammunition supply precludes their use for long periods. Deep targets are most favourable. In the combat of encounter, machine guns at the head of the main guard will try to act against dense bodies of the enemy, failing these against his skirmishers. For decisive combats they must be brought up as close to the enemy as possible with ammunition supply complete; at 500 yards they can fire over infantry so long as the latter are 3 yards below the target. The regulations insist that the commander who has the courage to wait till the last moment for engaging his machine guns at close ranges is assured of success. Portions of these regulations should be embodied in the regulations of the other arms to prevent misunderstandings. At present groups of 12 are attached to divisions, later these will be raised to 18. Their mode of action requires more profound study on the part of the chief commanders.

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Valise Equipment for Infantry.

Capt. Strubin proposes a new equipment, the principle of which is the division of the valise into three parts :—

1. For clothes and boots; weight empty	...	850 grammes.
2. For food and ammunition; weight empty	...	430 „
3. For the great coat; weight empty		270 „
Total	...	1,550 „

(about 3½ lbs.), against the present weight of 2,850 grammes (6⅓ lbs).

Each part is described and a list of its contents is given. It is noteworthy that the second valise is to contain a spirit lamp and apparatus for boiling and roasting food. The third valise is a piece of tent cloth 80 c.m. × 56, which can be used as a shelter in bivouac. Any portion can be omitted, according to the task the soldier may be called upon to perform. The advantages of such an equipment are insisted upon, and figures are given to show that spirit for cooking is cheaper than using wood, and is much less heavy to carry.

Military Bridges for Mountain Warfare.

The description of a plank girder bridge constructed by a class of sapper recruits in 1912. It was built on the bank parallel to the stream, one end over one of the abutments, counterweighted, and swung across on a pivot in the abutment. Length 13½ metres, width 2 metres, the floor fixed to the lower flanges of the girders. The calculations allowed for a dead weight of 150 k.g., and a moving load of 200 k.g. per square metre. Only nails and wire were used for building up the girders. The pieces might well be cut to length in the shops, and by this means no useless weight is carried and the short lengths are more easily conveyed along hill paths. The bridge was completed in 166 men-hours. Dimensioned drawings and photographs are published.

Collective Ranging.

This method of ranging was introduced by France in 1899. The Swiss "lunette panoramique," or telescope sight, is graduated to 6,400 millièmes in a complete revolution, hundreds being read on the base plate, and tens and units on a drum. The larger angles of direction and site can also be read on the battery telescope.

The millième is the artillery unit of height and width, the range can also be expressed in millièmes, but in a different sense. A millième is very nearly the angle at the point of observation subtended by 1 metre at a distance of 1 kilometre, and owes its name to the fact that the arc of circumference it measures is the thousandth part of the radius. Thus on a circumference of 1,000 m. radius the millième is nearly 1 metre, on a circle of 2 kilometres radius the millième measures 2 metres, etc.

Open and covered positions and the aiming point are described, the method of obtaining direction and of opening fire, and also the duties of the battery commander and of the layer. The employment of artillery is touched upon, especially against infantry and artillery.

The collective fire of groups of batteries is then described.

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AUTOMATIC ANGLE OF FIRE CONTROLLERS.

The object of these is to prevent a rifle being fired unless it is properly aimed for the given range. Two American types are here mentioned, that of Major W. A. Phillips, and that of Capt. and Qr.-Mr. F. D. Eley. The writer had been requested not to describe the first, but gives details, and photographs of two models of the second. The first of these models admits of firing at the given range or lower, the second can be adjusted to allow of fire at the given range, or at some angle above or below that range. The advantages claimed by the inventor for his controller are not altogether concurred in by the experimental committee at Monterey. However it is said that in the United States a large number of officers consider that, given the necessity of employing militia soldiers, some method of counterbalancing nervousness would be an advantage.

A.R.R.

RIVISTA DI ARTIGLIERIA E GENIO.

December, 1912.

FRANCE.

Aeronautics at the Great Manœuvres.—Some notices that were not previously reported are extracted from the *Technique Aéronautique* and the *Aérophile*, of the aeronautic exercises practised at the great French manœuvres during the current year. There were assigned to, (1), the blue army, one dirigible (Dupuy de Lôme), three squadrons of aeroplanes at two stations (the first two each with six Farman machines, and the third with six Blériot) and one squadron of aeroplanes to one station (three Borel and three Blériot); (2), to the red army, one dirigible (Adjutant Reau), two squadrons of aeroplanes at two stations (one of six monoplanes, Deperdussin, and the other of six Farman biplanes), one squadron of aeroplanes to one station (Hanriot), a mixed squadron of aeroplanes at three stations (two Bréguet, two Deperdussin, two Nieuport), three monoplanes, Blériot, to a station for cavalry, and three Blériot monoplanes for the artillery. There were in addition, in reserve:—one dirigible (Adjutant Vincenot) and five squadrons of aeroplanes.

The following was the order adopted for the "squadrillos":—In the 1st line, the aeroplanes, one automobile, and one motor bicycle for communication, six wagons with hauling ropes, which also carried a shelter tent for each machine. In the 2nd line, one aviation park with automobiles and motor bicycles for communication, autocars for offices, and for spare wings for the machines, etc. In the 3rd line, the reserve for reinforcements with automobiles, motor cycles and autocars. Altogether 60 aeroplanes and about 80 automobiles were employed.

In order to approach as far as possible the real conditions of war, the greater part of the aeroplanes arrived at the theatre of operations by aerial flight. Experiments were also made for transporting a squadron of aeroplanes from one position to another, taking the aeroplanes on

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ordinary roads. The time employed from the commencement of the operations up to the starting of the convoy was 1 hour 30 minutes. None of the various types of machines were judged to be superior one to the other, but it was found that all possessed characteristics which rendered them useful in various circumstances. It was observed that the troops during the manœuvres tried to escape being seen by the aerial observers by concealing themselves as much as they could, and that they occasionally succeeded.

New Type of Aeroplane.—In the *Génie Civil* of the 9th November it it reported that, at the exhibition of aeronautics held at Paris at the end of October, a new type of aeroplane with automatic stability was exhibited by Drzewiecki. The machine is based on the principle that, in the case of external disturbing forces displacing the aeroplane from its position of equilibrium, it immediately and automatically rights itself.

The monoplane Drzewiecki consists of two superficies placed in tandem; the front one is slightly smaller than the rear one, and at full flight makes an angle of incidence of 8° whilst the angle of the hinder one is inclined at an angle of 5°. Besides this, the curvature of the two planes is so arranged that, with a variation in the general inclination of the machine, the force exerted on the front plane varies less rapidly than that of the rear one. It happens then that, if the aeroplane is disturbed in its flight under the action of external influences, the sustaining force increases more rapidly in the front than in the hinder superficies, and that the two tend to bring the machine into its position of equilibrium. And *vice versâ* if the aeroplane inclines downwards the sustaining force is exerted on the front and the machine rights itself. The rudders of direction are two and are placed in the rear. The motor is placed about half-way in the machine.

Germany.

The *Aéorophile* of the 1st October states that a meeting took place at Gotha for experimenting on the throwing of bombs from aeroplanes under the following conditions:—(1). Throwing bombs of 7·100 k.g. weight on a square of 100 m. from a minimum height of 200 m.; at a height exceeding 400 m. the value of the results was increased 50 per cent.; and over 600 m. was doubled. (2). Throwing bombs from a minimum height of 50 m. on an aerial target consisting of an anchored balloon, 30 m. in length and about 3 m. in diameter fixed at 4 m. from the ground. (3). Taking photographs from a height not less than 600 m. (4). Manœuvres of aeroplanes, with a view to impeding the dirigible Victoria-Luise, belonging to the enemy, employed in reconnoitring and carrying information of the friendly troops. The winner of the meeting was the biplane A.G.O. with an Argus motor of 100 H.P. In the first stage the target was struck by 7 bombs out of 10 which were thrown.

The same Journal of the 1st November states that experiments are being carried out in Germany with a special projectile designed to fire against dirigibles, and to be able not only to perforate the envelope but also to cause an explosion of the gas. This projectile is thrown with the old German rifle model 71 of 11 m.m. calibre. There is a small blade

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within the projectile which opens out on leaving the rifle, and this causes irregular gashes in the envelope of the balloon thus allowing the gas to escape. A small spring is also put in action which strikes a fulminating cap. placed inside the projectile. Recent trials carried out at the polygon of Neumanswald would seem to have given satisfactory results.

Protection of Cruisers against Aeroplanes.—The same Journal of 1st October reports that the four cruisers which are being built this year in Germany will be provided not only with armoured bridges to resist the attacks of aeroplanes, but also with guns of a special type to fire against dirigibles and aeroplanes. The new cannon will be able to fire at an angle of 80° and will throw projectiles of 13 k.g. to a height of 8,000 m. These projectiles, which will scatter their fragments over a vast field, will contain a powder—producing smoke—thus helping to regulate the fire.

SPAIN.

Sections of Miners for Certain Infantry Regiments.—In view of recent experiments a section of miners has lately been created for each of the eight regiments of infantry constituting the 1st and 2nd Divisions (Madrid and Sevile), and for the six battalions of sharpshooters constituting the 1st Brigade of sharpshooters (Madrid). Each section consists of 1 officer, 1 sergeant, 2 corporals and 10 soldiers, and is equipped with the following explosive material:—144 bombs, 96 detonators, in addition to the material necessary for the preservation of the explosives, and for practical exercises.

Creation of a Railway Regiment.—We read, in the *Bulletin de la Presse et de la Bibliographie Militaires* of the 31st October, that in Spain the railway battalion of four companies is transformed into a regiment with eight active companies, and eight depôt companies, the first eight being subject to active service, and the other eight companies being enrolled as on unlimited leave.

E. T. THACKERAY.

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CORRESPONDENCE.

"QUALIFIED INSTRUCTOR" EXAMINATION PAPER.

SIR,

The following paper was recently set at an examination for "Qualified Instructor." It is somewhat different to the style of papers usually given and proved most successful in testing the general knowledge of the candidates.

Yours faithfully,
R. N. HARVEY, *Major, R.E.,*
C.I.F.

Chatham, 15th May, 1913.

GENERAL IDEA.

In all the following questions you are the Serjeant of No. 2 Section, 17th (Field) Company, R.E.

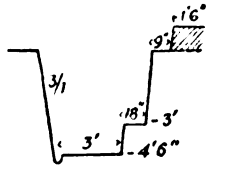
This section forms part of the following force:—1 Infantry Brigade; 1 18-pr. battery R.F.A.; 1 Section R.E.; 1 Company Divisional Train.

The section consists of:—Lieutenant A——; 1 Serjeant—yourself; 1 Corporal; 2 2nd Corporals; 2 Lance-Corporals; 30 Sappers; 4 Drivers; with the following transport:—8 bicycles; 2 R.E. tool carts; 1 forage cart; 1 pack mule.

This mixed brigade is at first at GRAVESEND and in the later questions is following a defeated enemy who is retiring *viâ* WROTHAM—YALDING—HEADCORN—TENTERDEN. That is S.S.E. from GRAVESEND across the river MEDWAY.

1. Whilst at GRAVESEND on the 21st May, 1912, it is decided to strengthen the outpost line to the south of the town.

At No. 1 picquet 200 ft. run of fire trenches of section shown in the figure are to be constructed.



A working party of 1 company of Infantry (4 Serjeants, 80 R. & F.) is to be ready to commence work at 7 a.m. on the 22nd May, and is to bring with it 50 picks and 50 shovels.

The ground is gravelly—similar to that on TOWER HILL at UPNOR—and the rates of excavation may be taken as two-thirds of those given in the textbook (M.M.E., 1911).

(*a*). Show on section what will be the tasks for each relief.

(*b*). Calculate when each relief will finish.

(*c*). What tools or stores shall you take with you assuming that you are lent to superintend the work.

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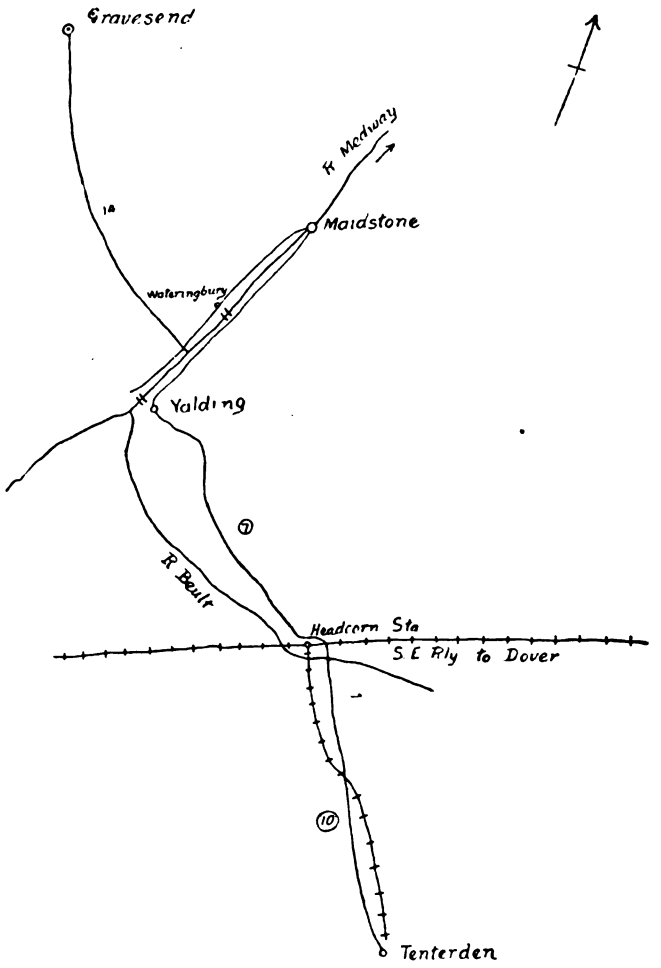

2. The Column marches from GRAVESEND on the 23rd May at 7 a.m. The Section R.E. is with the Advanced Guard, and reaches the R. MEDWAY at 2 p.m. Lieut. A., who has been forward with the Vanguard, meets you and directs the Section into a meadow on the south side of the road, ordering you to arrange watering for the column which is to bivouac north of the road. The MEDWAY at this point flows from south to north, is sluggish, and about 4 ft. deep near the bank. The meadow bank drops 3 ft. vertically to the water. The meadow is dry and hard and has a front of 200 yards on the river. There are several wire fences in the vicinity.

State exactly what arrangements you make and illustrate your answer by a sketch plan.

3. At 3 p.m. on the same day—23rd May—you have just finished the watering arrangements, when an Infantry orderly brings you the following message :—

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No. 23.

YALDING MILL,
23rd May, 1912.

SERJEANT X., R.E.

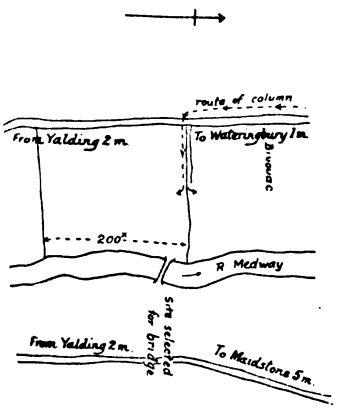
I am proceeding to TONBRIDGE and do not expect to be back in bivouac before 7 p.m.

Construct a trestle bridge over the MEDWAY just below your watering places, to carry infantry in fours; with 15-ft. bays if you can obtain sufficiently long road-bearers.

Timber in plenty in a builder's yard in WATERINGBURY—1½ miles south of our bivouac. An infantry working party will arrive at 5 p.m. with tools to prepare the approaches.

By cyclist orderly at 2.30 p.m.

Y.A., *Lieut.*, *R.E.*



You select a site and find by field geometry that the river is 55 ft. wide bank to bank. One of your sappers who is a swimmer finds that the bottom shelves gradually and that for about 10 ft. in the middle he is out of his depth; also that the bottom is muddy. The horses have by now (3.15 p.m.) been watered and fed, and the cook reports dinners ready.

What is your procedure?—very briefly.

4. On arrival at the builder's yard mentioned above you find the following stores:—

4 scaffold poles 30 ft. long, 9-in. butt, 6-in. tip.
20 ,, ,, 16 ft. ,, 7-in. butt, 5-in. tip.
120 planks 12 ft. long by 9-in. by 1¼-in.
100 9-in. by 3-in. deals, 14 ft. long.

There is also a 24-in. circular saw at work, and cross-cut saws are available.

(*a*). Put down in the form of a table as under the stores you select, and the purpose to which you allot them:—

	No. Required.	Stores Selected.
Standards	..	
Transoms	..	
Ledgers	..	
Etc., etc.	..	

(*b*). Prove that the timbers which you have selected for transoms and for road bearers are strong enough.

Formula:— $W = \frac{\frac{5}{4}bd^2}{L}$.

5. You have been unable to obtain spikes or rope, but on your return to the site of the bridge you find that Corporal C. has collected a sufficient quantity of wire apparently of No. 12 gauge.

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(*a*). You have no wire gauge—suggest a method by which Corporal C. could have ascertained the strength of the wire.

(*b*). Corporal C. did ascertain that the *breaking strain* of the wire was 456 lbs. How many turns will you have put on each transom lashing? Give your reason.

(*c*). If you had 1½-in. hemp rope available, how many turns would you make the transom lashing? Give your reason.

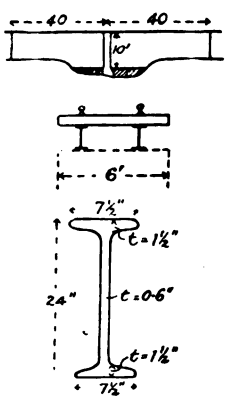
6. The column arrived at TENTERDEN on 25th May. A damaged gun has to be hoisted into a railway truck by means of a derrick which the section has put up. The main tackle consists of 2 treble blocks, a snatch block and a 3-in. fall. The gun weighs 24 cwt. There is much work to be done.

(*a*). How many men will you leave with Corporal C. to hoist the gun into the truck? Give your calculations.

(*b*). Lieut. A. gave you a sketch of the derrick showing strain on back guy to be 12 cwt. You can only get 3-in. rope. Is it strong enough? What will you do if it is not?

7. The enemy having received reinforcements, the column has to retire from TENTERDEN on May 26th. Lieut. A. has been wounded. You receive orders from the Brigade Major to destroy the TENTERDEN—HEADCORN light railway in the vicinity of HEADCORN, sufficiently to prevent the enemy making use of it for 48 hours. Your section, when you receive the order, is in rear of the main body and about 4 miles from HEADCORN; only four of your bicycles are by now in working order. You take three men, giving each 6 lbs. of guncotton, and you yourself take a handsaw, spun yarn, instantaneous and safety fuze, detonators and primers, and push on to HEADCORN Station.

You are delayed in pushing past the columns and by the time you reach HEADCORN Station, you calculate that you have probably only about 1 hour in which to do your work, before the rear guard which is being pressed by the enemy is driven back to HEADCORN. Hastening back along the line from HEADCORN towards TENTERDEN you find at ¼ mile from the station a bridge over the R. BEULT, constructed as shown in the figure. The centre pier is of concrete 2 ft. thick and 6 ft. wide, standing in about 1 ft. of water. The track is carried over each span by two steel I-beams of section as in figure. The railway fence is "post and rail."



(*a*). State how you propose to destroy the bridge, giving sketches of your arrangements of charges, fuzes, etc.

(*b*). Give calculations of any charges you decide to use.

Formula:—For masonry demolitions charge $= \frac{1}{2}$ BT^2.
For destroying steel plates charge $= \frac{3}{2}$ Bt^2.

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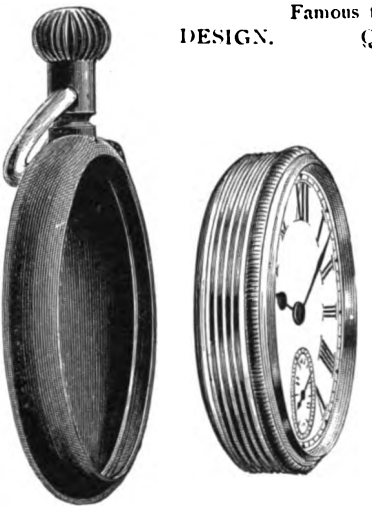

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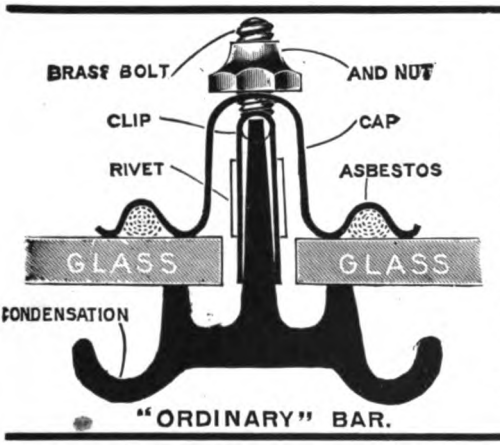

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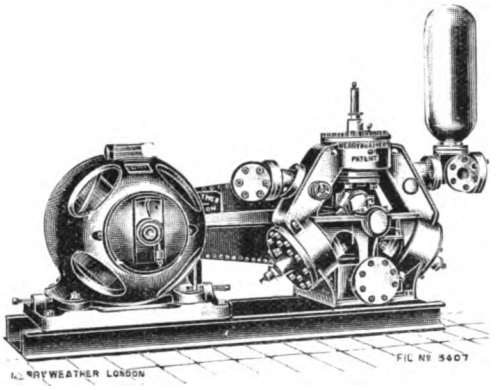

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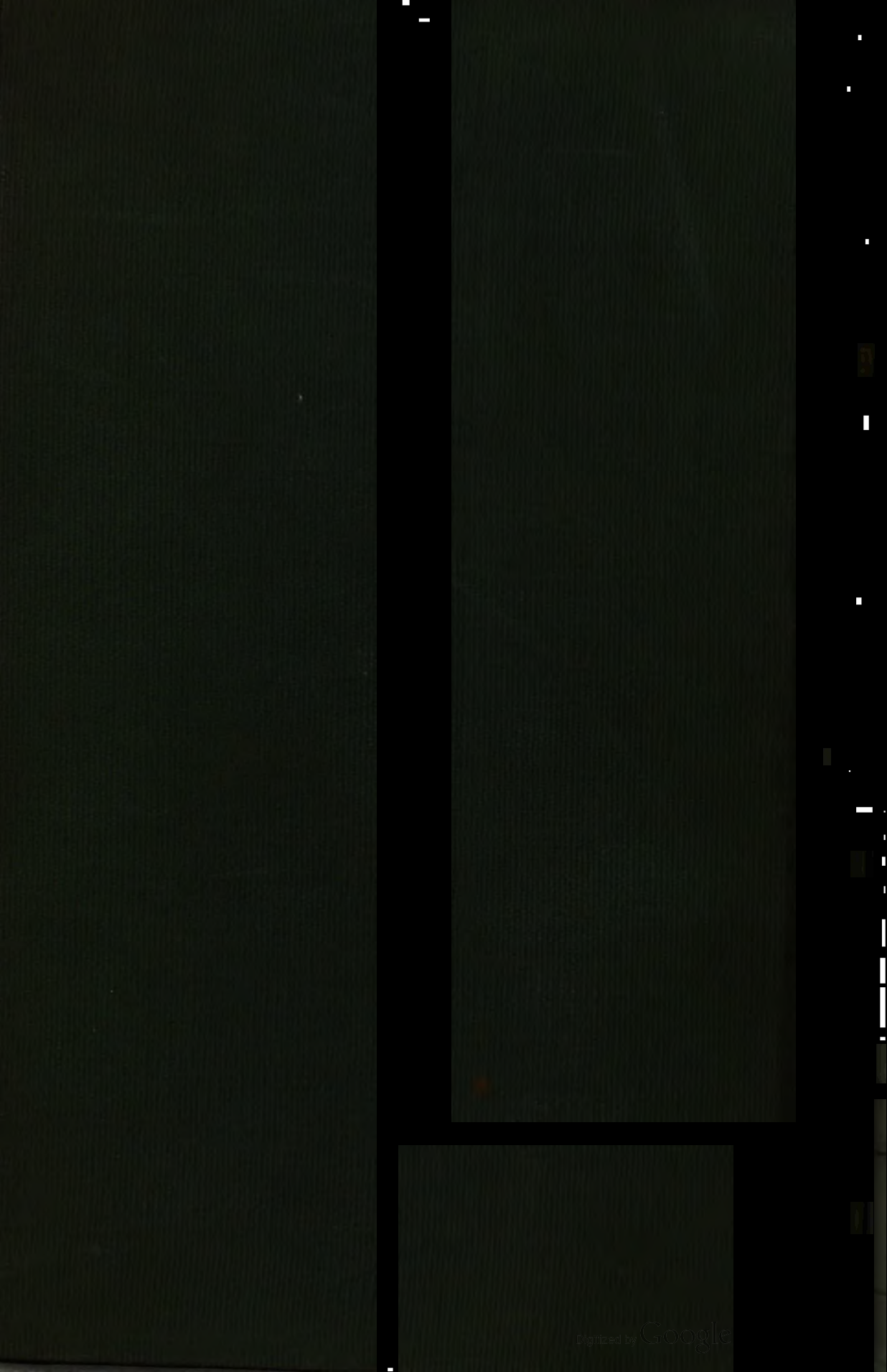

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